ENGINEERING:

An Illustrated Weekly Journal.

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Session 1916-17.

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Lecturer in Mining: S. W. Price, Assoc. R.S.M., F.G.S.

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Services of a Principal for

the Technical School.

The gentleman appointed must be specially qualified in Engineering subjects, and ineligible for Military Service, will be required to undertake (under the direction of the Director of Education) the organisation and management of all departments of the Technical School, to take part in the instruction there given, and to advise, when required, on the preparatory Technical work undertaken in the Evening Continuation Schools.

Salary £400 per annum.

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Applications, furnishing particulars of professional and technical training, experience in teaching and organisation, together with copies of three recent testimonials, references, &c., should be forwarded to the Director of Education, Town Hall, on or before the 2nd September, 1916, and be endorsed "Principal of Technical School."

By Order,
L. Hewlett,
Town Clerk and Clerk to Local Education Authority.
Town Hall, Barrow-in-Furness,
27th July, 1916. E 744

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Appointment of Head of the Mechanical and Civil Engineering Department.

The Education Committee invite

Applications for the Position

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Salary: £225 increasing by £12 10s. per annum to £350.

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SUPERINTENDENTS will be REQUIRED for the Uganda Railway. Salary £350-£20-£550 per annum. Free first-class passages and quarters.

Candidates must have had a thorough training in locomotive workshops and offices, and possess a sound knowledge of footplate and general running work, and some experience of managing and supervision of staff.

Applications for these posts are invited by the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W., from Candidates possessing the necessary qualifications although not immediately available for service. E 758

Wanted, Mechanical Engineer

DRAUGHTSMAN, accustomed to oil fuel installations both land and marine; applicants must be over Army age or young soldier who is unfit for further military duties would be acceptable.—No one at present employed on Government work will be engaged.—Applications to be made to your nearest LABOUR EXCHANGE, mentioning this Journal and R 724.

Draughtsmen, Senior and

JUNIOR REQUIRED, preferably used to Motor Car and Aero Engine work, for London district. No one on Government work will be engaged.—Apply, stating age, experience and salary required to your nearest LABOUR EXCHANGE, quoting No. A 2170. E 782

Draughtsman, with experience

on all types of electric cranes. Government controlled firm, Manchester district. State age, wages, and experience. No person already employed on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, mentioning this Journal and R 505.

Draughtsman for Machine

Tool Firm, high-class work; good opening for smart man; No one on Government work can be engaged.—Apply, with full particulars, experience, age, salary, &c., to your nearest LABOUR EXCHANGE, mentioning this Journal and R 761.

Draughtsmen (Two) Required

IMMEDIATELY, used to heavy Petrol Engine details. No application will be considered from anyone already employed on Government work, or residing outside the 10 mile radius.—Apply in first case, giving full particulars of experience and salary required to E 756, Offices of Engineering.

THE "GROWTH" OF INTERNAL-COMBUSTION ENGINE CYLINDERS.

By J. E. HURST.

THE phenomenon of "growth" of cast-iron when subjected to a series of repeated heatings and cooling, first brought to notice by Outerbridge and so exhaustively investigated by Professor Carpenter and H. F. Rugan, is now very familiar. Essentially this phenomenon, which is found particularly in grey irons only, was shown to be due to the internal oxidation of the iron and its constituente by the hot furnace gases which penetrate into the cast iron by way of the graphite plates. There is still some doubt as to the exact order in which the various constituents are attacked by the oxidising gases; but it is perfectly certain that in a fully "grown" cast iron the whole of the constituents including the iron are in a more or less degree oxidised.

The repeated absorption and expulsion of the gases and the gaseous products resulting from the oxidation of the carbon, together with the changes in volume due to the formation internally of

FIG. 1. NORMAL IRON, SHOWING GRAPHITE PLATES. UNETCHED. MAGNIFIED 78 DIAMETERS.

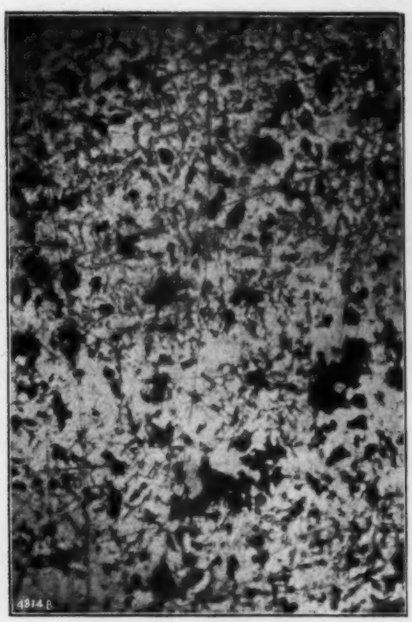


FIG. 2. HEAT-TREATED IRON, SHOWING SWELLED GRAPHITE. UNETCHED. MAGNIFIED 78 DIAMETERS.

oxidised matter, results in the peculiar phenomenon of growth and the eventual disintegration of the mass.

Professor Carpenter, in his investigation, showed that the presence of certain constituents, principally manganese and phosphorus, tend to diminish the extent of the growth, whilst other elements, such as silicon and graphite, up to certain percentages, increase the total extent of the phenomenon. According to the above investigators these phenomena were found to commence at about 650 deg. C., and appeared to reach a maximum at about 750 deg. C. Beyond 900 deg. C. very little further expansion was noted.

Another peculiar phenomenon somewhat allied to the above was broached in America some little time ago (*The Foundry*, January, 1910). Cast-iron fittings on superheated-steam mains, after a few months' service, developed cracks and small changes in shape and volume, whilst in addition the mechanical strength of such fittings was observed to fall off considerably. The maximum temperature to which such fittings were exposed was 500 deg. C., which is much below that at which "growth" was shown to take place in Carpenter and Rugan's experiments. The slight permanent changes in volume which take place under such conditions are, in all probability, of a different origin to the phenomenon "growth."

Examples of the former phenomenon "growth" are very common amongst cast-iron furnace parts, such as furnace doors, fire-bars, &c. Grey cast-iron chills, used in the moulding operations in the iron foundry, are frequently found to have grown to a remarkable extent. Beyond the above-mentioned, in connection with the latter phenomenon, very little further would appear to be known.

Experience with internal-combustion engine liners shows a phenomenon which would appear to be very much allied to this "growth." When a new liner is put to work it is invariably necessary to make some slight adjustment to the piston. Apart from such considerations as slight inaccuracies in machining, &c., this adjustment is often necessary owing to the slight changes in volume of the cast iron of which the liner and piston are constituted. This is further borne out by the fact that looking back over a series of examples the character of the iron would seem to influence the extent of adjustment to be made. If the iron should be in any degree open grained, or rather contain more large graphite plates, the degree of adjustment necessary is greater than in the opposite case. In so far as can be judged by observation over a long period, the grain size, and more particularly the size of the graphite, is the controlling factor. The difficulty of obtaining any definite information as to the cause of this phenomenon will no doubt be obvious. The miscroscope gives little information. However, in the author's opinion this change in volume would seem to be due to an expansion amongst the grains composing the liner and piston surfaces, brought about by the rapid succession of changes of pressure within the cylinder. This results in the entrance of gases and lubricant into the interstices of the grains by way of the graphite plates, an action which is no doubt facilitated by heat; hence the slight changes of volume.

Experience with micro-sections from such surfaces frequently shows the presence of lubricant, which is oft-times troublesome during the preparation of such specimens, even after the specimens have to all intents and purposes been thoroughly cleaned.

Undoubtedly this phenomenon results in a falling off of the mechanical strength figure; but it is considered that the change in volume is confined to a comparatively thin layer of the surface only, and it is obvious that the extent will be controlled largely by the grain size and the internal gas pressure in the cylinder. A loosening of the surface grains is an invariable consequence of this change in volume, a factor which is of great importance in determining the wear of liners and pistons.

In the internal-combustion engine, and more particularly in engines of the Diesel type, the piston head is heated to an excessive temperature, quite distinctly red. This heating is local and extends over an area in the centre of the piston head, on which the flame produced by the combustion of the charge impinges. The effect of this heat on the material composing the piston is to eat away a layer of the metal, and if the material be certain kinds of cast iron radiating cracks are produced extending from the centre of the heated area across the piston head. Such cracks are commonly put down to the growth of the metal under the influence of the alternate heating and cooling. However, an examination of specimens of this type of occurrence would lead one to the conclusion that this is not growth in the strict sense of the term. The chemical analysis of such specimens does not undergo any appreciable change in total composition, nor is there any trace of oxidation in the actual metal; and further, in direct opposition to Carpenter and Rugan's conclusions respecting growth, a reduction of the phosphorus content of the iron entirely eliminates the troublesome cracks.

Undoubtedly these cracks are the product of a series of events occurring internally in the cast iron under the special circumstances. On heating common foundry iron up to a temperature of from 750 to 900 deg. C., a range of temperatures which includes that of the Diesel engine piston top, it is observed that some of the graphite is absorbed, forming the austenite (hardenite) solid solution. The extent of the graphite absorption at any particular temperature depends largely upon the time of heating and the volume of the material. This absorption is accompanied by a formation of numerous cavities larger in cross-sectional area than the original graphite plates (see Figs. 1 and 2). On cooling down slowly the free carbon is re-deposited, but this time it is not necessarily in the graphitic form, but in a condition more of the nature of temper carbon. The phosphorus assists this absorption of carbon considerably, though exactly the manner in which it does so is as yet somewhat obscure. It is observed that the absorption of carbon takes place with increased rapidity in the high phosphorus irons, whilst in low phosphorus irons the action is brought about with some difficulty. It is further noted that at the higher temperature, 900 deg. C., the phosphorus tends to liquate and aggregate into larger rounded areas. In the red-hot piston top of the Diesel engine some of the free carbon is absorbed in a like manner as above described. The extent of carbon absorbed, limited, of course by the saturation point at the particular temperature, depends largely on the length of time and the bulk of the metal heated, and in addition on influence of the phosphorus content. On cooling down this absorbed carbon is deposited in the temper carbon form, a fact which will account for the distinctive greyness of these overheated pistons when fractured. This absorption and re-precipitation of the carbon alone, apart from the expansion of the graphite plates shown in Fig. 2, the reason for which is not quite clear, will set up a series of repeated expansions and contractions, the effect of which will be obvious. In addition, it will be appreciated that at the temperature of this particular portion of the piston the phosphide eutectic is perilously near to its melting point, and it is in all probability a fact that liquation does occur, a phenomenon which will further assist in the production of cracks.

The high and constantly changing gas pressure in Diesel engine cylinders will also largely assist in the production of cracks by the gas forcing its way into the cavities and cracks produced by the absorption of the graphite, and the liquation of the phosphide eutectic, and there assisting in the rending apart of the component grains. This action is not confined to a thin layer of the exterior surface only, but extends right into the interior of the metal. In this respect it is unlike the former case mentioned.

In the case of low phosphorus irons, in which the chances of liquation of phosphide eutectic are reduced to a minimum, all trouble from cracked piston heads is practically absent. It will be quite evident that "growth" in the strict sense of the term is not met with in the Diesel engine cylinder, and that the "cracking phenomenon" is due to other causes, which are the repeated solution and precipi-

PASSENGER LOCOMOTIVE, "K 4 S" CLASS, FOR THE PENNSYLVANIA RAILROAD.

CONSTRUCTED AT THE JUNIATA WORKS OF THE COMPANY; MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.

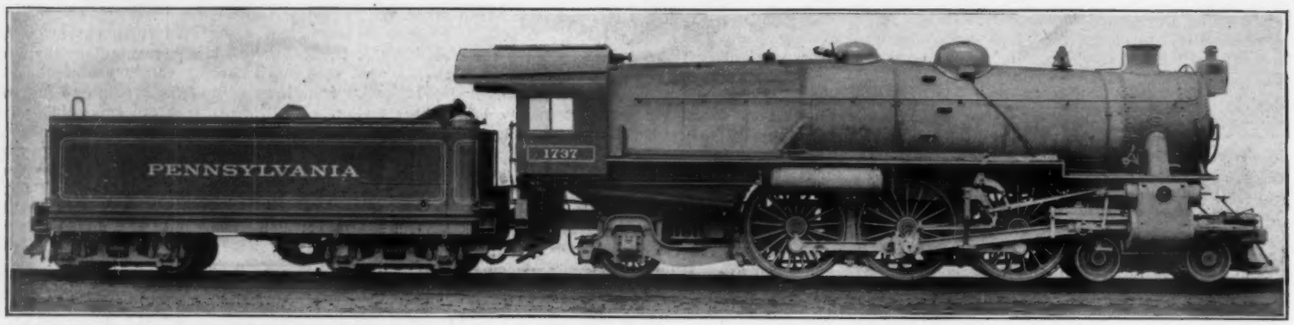


Fig. 1

Fig. 2.

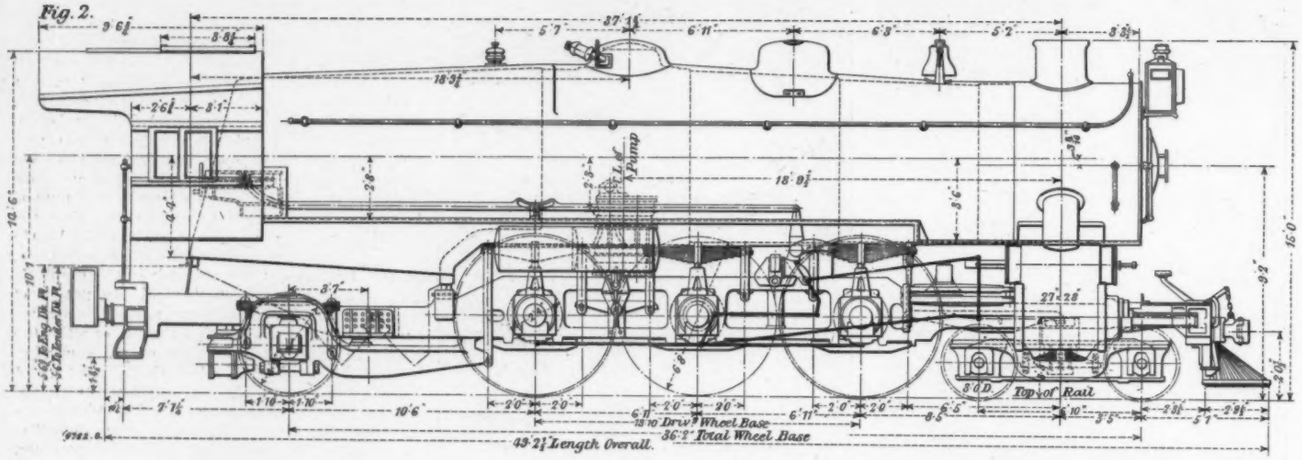


Fig. 3.

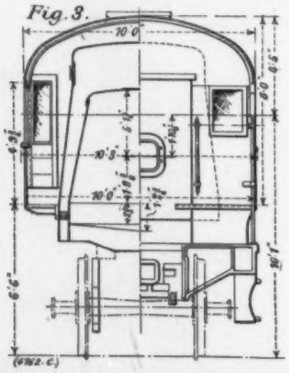
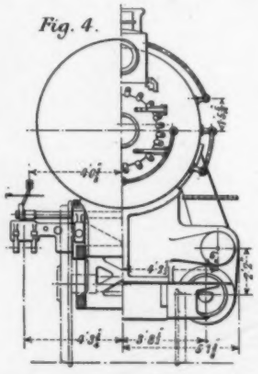


Fig. 4.



tation of the free carbon, which is assisted by the phosphorus content, and the liquation of the phosphide eutectic, together with the influence of the alternating variations of the internal gas pressure. The exact mechanism of the influence of the phosphorus is not yet fully clear. One or two interesting points arise on the subject of growth in general which are worthy of inclusion here. The first is in connection with the order in which the constituents of cast iron are oxidised under circumstances promoting growth. Dr. Stead, in the discussion on the above-mentioned investigation, stated that in certain cases of growth that he had met with, the iron was primarily oxidised, followed by the silicon, and "curiously the graphite was the last to be oxidised." The fact that at the temperature of about 850 to 950 deg. C. the greater part of the graphite has re-dissolved in the solid solution would seem to explain this curious occurrence.

The second point is that the constant re-absorption and re-precipitation of the free carbon in the form of temper carbon, in other words, the conversion of the graphite carbon into temper carbon by exposure to heat, is responsible for the dull grey fracture of cast-iron specimens heated for prolonged periods of time. In conclusion, the author wishes to offer his thanks to Messrs. Richard Hornsby and Sons for kind permission to publish these results.

HIGH-POWERED LOCOMOTIVES ON THE PENNSYLVANIA RAILROAD.

About three months ago,* in an article entitled "Large-Boiler Locomotives," we called attention to the recent practice of the Pennsylvania Railroad Company with regard to the employment of locomotives provided with exceptionally large boiler power, and we are now able, through the courtesy of Mr. J. T. Wallis, the General Superintendent of Motive Power, to place before our readers detailed particulars of those engines. The classes of engine with which we propose to deal are those known in the Pennsylvania Company's classification as the "K 4 S," the "L 1 S," and the "E 6 S," types, and we shall in the first place confine our attention to the first and second of these classes.

The "K 4 S" engines are of the "Pacific" type and the general design is shown by Figs. 1 to 4 on the present page. The first locomotive of the class was built at the Juniata shops, Altoona, early in 1914. The engine has a four-wheeled leading truck, six coupled wheels 6 ft. 8 in. in diameter, and a two-wheeled trailing truck. The "K 4 S" class of engines was designed to deal with the heaviest passenger trains on the mountain grades of the Pennsylvania line, and it has proved very successful. The traffic referred to was previously dealt with by engines of the "K 2 S A" class, having cylinders 24 in. in diameter by 26-in. stroke, driving wheels of the same diameter as the "K 4 S" class, 4,633·7 sq. ft. of heating surface, 53·7 sq. ft. of grate surface, 179,900 lb. load on the driving wheels, and weighing in working order 293,200 lb. As will be seen by the table of chief dimensions given later on, the "K 4 S" class have 12.8 per cent. more heating surface, 28·9 per cent. more grate surface, 36·3 per cent. greater cylinder capacity, and 12·8 per cent. greater load on the driving wheels, while the total weight in working order has only been increased 5·4 per cent.

The "L 1 S" engines, on the other hand, are of the "Mikado," or 2-8-2 type, the general design being shown by Figs. 4 to 8 on the opposite page. These engines have a two-wheeled leading truck, eight-coupled wheels, 5 ft. 2 in. in diameter, and a two-wheeled trailing truck similar to that on the "K 4 S" type of engines. The particular engine, No. 1,752, shown by the photograph reproduced in Fig. 5 is the first example of the type, and it was

* See Engineering, vol. ci., page 405.

GOODS LOCOMOTIVE, "L 1 S" CLASS, FOR THE PENNSYLVANIA RAILROAD.

CONSTRUCTED AT THE JUNIATA WORKS OF THE COMPANY; MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.

FIG. 5.

Fig. 6.

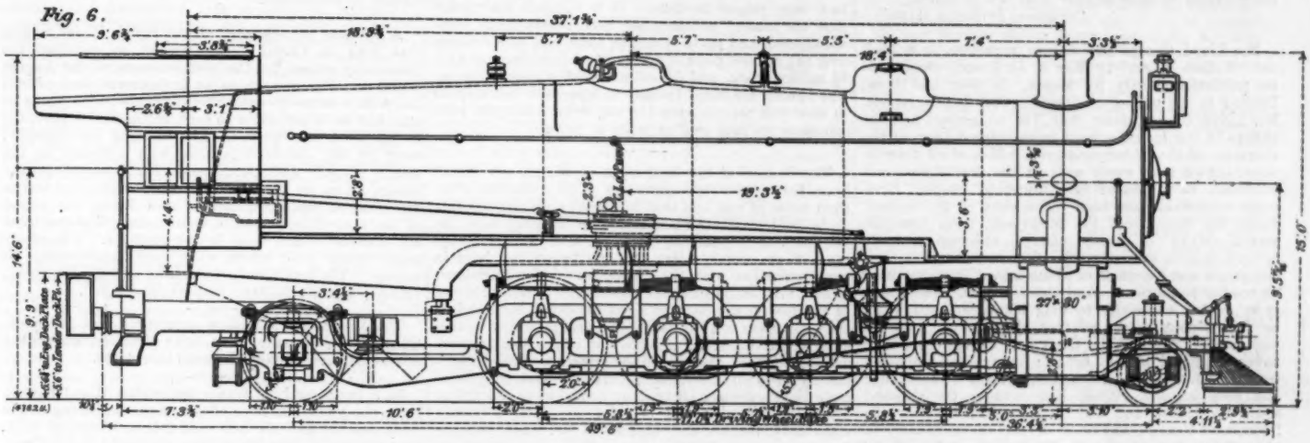


Fig. 7.

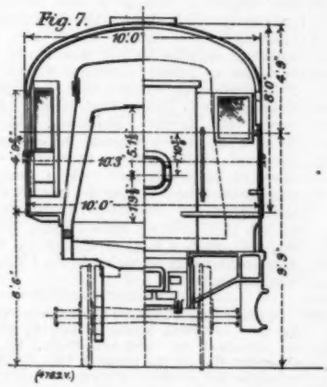
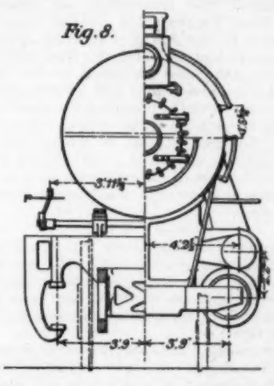


Fig. 8.



built at the Juniata shops of the company in April, 1914.

We give in the annexed table the chief data relating to the two types of locomotive above mentioned, and in our next article we shall commence our description of the constructive details.

Table giving chief data relating to Pennsylvania Locomotives of Types "K 4 S" and "L 1 S."

Class.	"K 4 S."	"L 1 S."
Diameter of cylinders ...	2 ft. 3 in.	2 ft. 3 in.
Stroke of pistons	2 ft. 4 in.	2 ft. 6 in.
Distance apart of cylinders, centre to centre	7 ft. 5 in.	7 ft. 6 in.
Diameter of piston valves ...	1 ft. 0 in.	1 ft. 0 in.
Width of steam ports ...	2⅛ & 2 1/16 in.	2¼ in.
Travel of valves	7 in.	6 in.
Lap "	1 5/16 in.	⅞ in.
Number of pairs of driving wheels	Three	Four
Diameter of driving wheels	6 ft. 8 in.	5 ft. 2 in.
Diameter of driving axle journals	11 in.	11 in.
Length of driving axle journals	15 in.	15 in.
Length of driving-wheel base	13 ft. 10 in.	17 ft. 0½ in.
Total wheel base of engine ...	36 ft. 2 in.	36 ft. 4½ in.
Diameter of wheels of leading truck	3 ft. 0 in.	2 ft. 9 in.
Diameter of trailing wheels...	4 ft. 2 in.	4 ft. 2 in.
Diameter of leading truck axle bearings	6½ in.	6½ in.
Length of leading truck axle bearings	12 in.	12 in.
Diameter of trailing axle bearings	6½ in.	6½ in.
Length of trailing axle bearings	12 in.	12 in.
Minimum internal diameter of boiler	6 ft. 4⅛ in.	6 ft. 4⅛ in.
No. and outside diameters of tubes	236 × 2¼ in. 40 × 5½ in. 160 × 1¾ in.	236 × 2¼ in. 40 × 5½ in. 160 × 1¾ in.
Length of tubes between tube plates	19 ft.	19 ft.
Flue area through tubes ...	8.34 sq. ft.	8.34 sq. ft.
Length of fire-box inside ...	10 ft. 6 in.	10 ft. 6 in.
Width " " "	6 ft. 10 in.	6 ft. 10 in.
Fire-grate area	70 sq. ft.	70 sq. ft.
Heating surface of fire-box (including arch tubes) ...	315 "	315 "
Heating surface of tubes (ordinary)	3,731 sq. ft.	3,731 sq. ft.
Heating surface of tubes (superheating)	1,720 "	1,720 "
Heating surface (total) ...	5,766 "	5,766 "
Ratio of heating surface to grate surface	82.37 to 1	82.37 to 1
Ratio of external flue heating surface to fire-box heating surface	17.30 to 1	17.30 to 1
Steam pressure per sq. in. ...	205 lb.	205 lb.
Weights of Engines in Working Order.		
On leading truck	53,640 lb.	29,600 lb.
" first pair of driving wheels	67,550 lb.	56,200 lb.
" second " " "	67,630 lb.	57,200 lb.
" third " " "	66,650 lb.	62,000 lb.
" fourth " " "	—	64,800 lb.
" trailing wheels	53,420 lb.	50,900 lb.
Total weight	201,830 lb.	240,200 lb.
Tractive power per pound of mean effective pressure per sq. in. on pistons	255.15 lb.	352.74 lb.
Tractive power with mean effective pressure per sq. in. on pistons equal to 85 per cent. of boiler pressure ...	44,460 lb.	61,465 lb.
Ratio of weight on drivers to tractive power	4.54 to 1	3.91 to 1

(To be continued.)

TRADING WITH THE ENEMY.—Consolidating Statutory List No. 5a, complete to July 18th, with Statutory Rules and Orders, has just been published at the price of twopence. It can be obtained from Messrs. Wyman and Sons, of Fetter-lane, E.C., and from H.M. Stationery Office.

ELECTRICITY SUPPLY.—A Conference has taken place between the Electricity Supply Committee of the Institution of Electrical Engineers and the Joint Committee of the I.M.E.A. and the Incorporated Association of Electric Power Companies in regard to co-operation between the Committees. It has been agreed that the Institution of Electrical Engineers' Committee will devote its attention to the question of electricity supply from the point of view of the requirements of the country as a whole, and will deal with the engineering aspect of the matter, while the Joint Committee will go into more immediate questions of organisation and linking-up of existing undertakings, &c.

INDUSTRIAL NOTES.

Following upon our note on page 55 *ante*, we are glad to put on record the two following telegrams which have passed between the Management Committee of the General Federation of Trade Unions and Sir Douglas Haig :—

"To General Sir Douglas Haig, General Headquarters, British Expeditionary Force.

"The Management Committee of the General Federation of Trade Unions, representing over a million British workers, sends sincere congratulations to you, to your Staff, and to your heroic soldiers on the successes achieved since July 1. Also wishes speedy recovery of the wounded, and expresses deepest sympathy with the relatives of those who died in defence of honour and civilisation.

"(Signed) Appleton, Secretary."

"To Secretary of General Federation of Trade Unions.

"Your inspiring message has appealed to us all. On behalf of my Staff, the Army in France, and myself I beg to express to the members of the General Federation of Trade Unions our warmest thanks for their kindness in congratulating the British Army in France on its success. All ranks realise how much this success is due to the patriotism, self-denial, and whole-hearted co-operation of their brother workmen at home.

"(Signed) Douglas Haig."

Mr. Lloyd George has written a preface to a book on "Welfare Work," by Miss E. D. Proud, which is to be published shortly by Messrs. G. Bell and Sons. Dealing in the preface in question with female labour, Mr. Lloyd George states that "in no respect has the change in our factories been more marked than in the character of the labour employed. Men of all descriptions, drawn from every walk in life, half-skilled and unskilled, have poured into munition works. Even more remarkable has been the advent of the women. From the shop, from the workroom, from domestic service—many of them utterly unaccustomed to factory or even manual work—they have come in their thousands and hundreds of thousands. There has been no readier patriotism. And these women, these young girls, submit cheerfully to long hours, to hard work, to monotonous work, so that they may 'beat the Germans.' Many of the firms that engage them have never employed women before; many that employed tens now employ hundreds and thousands. The change has been sudden. When last summer the demand arose for shells, and still more shells, to save the liberties of Europe, and from one end of the country to the other engineering and other shops and factories were converted to the making of munitions, the response of the women and of other workers was overwhelming. Before the problems of the change could be solved, the new hands were already at work at the machines.

"The conditions of their work soon engaged my attention. If a maximum output was to be reached—still more, if it was to be maintained for a protracted period—it was all-important that the health and well-being of the workers should be carefully safeguarded. This was specially the case with women and young people. The workers of to-day are the mothers of to-morrow. In a war of workshops the women of Britain were needed to save Britain; it was for Britain to protect them. Steps were taken immediately to improve the conditions under which both women and men were working.

"A strong Departmental Committee was appointed to consider the question of the health of munition workers. A canteen committee was set up by the Central Control Board (Liquor Traffic) to assist firms in the construction of canteens and to afford financial assistance in conjunction with the Ministry of Munitions. A committee was formed, in association with the Home Office, to secure a weekly rest to the workers and to regulate the hours of their labour. These have been greatly reduced, especially in the case of women. At the Ministry itself a new department was created, charged with the general responsibility of securing a high standard of conditions for all workers in munition factories."

The works of the Garston Bottle Company, Limited, were opened last week, in the presence of a large number of visitors. Addressing these, Sir Wm. B. Peat, chairman of the company, remarked that while we were at war the theory was to make all we could in the country, keep our money in the country, employ our labour in the country, and double our plant in the country. That policy must be maintained, as it was the sure policy of prosperity. He hoped in the future we should be able to manufacture what we wanted, be able to sell what we wanted, and be able when stress and attacks came to provide for our protection within the four corners of our Empire.

Mr. John J. Calder, managing director, stated the new works were notable on two accounts; in the first instance they were one of the new works started and completed since the outbreak of war to render us independent in an article for which we had hitherto been largely dependent upon our enemies; and, secondly, it was a work which by use of machinery was able to employ highly skilled labour which earned a good remuneration. The cost of the bottles, he added, amounted to between 30 and 40 per cent. of the total cost of an export case of beer, which showed how vital it was that we should have bottles at a reasonable price and be independent of foreign supplies. It was their intention at the Garston Bottle Works to show a preference for the employment of those injured soldiers who were capable of doing the work.

Dealing with the clothing of the British Army, *The Textile Mercury* says that some idea of the quantities which have passed into consumption can be got from a statement of the orders given between August, 1914, and March 31, 1916. Of woollen and worsted cloths the total was 117 million yards, or 61 times the established peace average. Of flannel there were 84 million yards, or enough in twelve months for 41 years by old reckonings. Of cotton cloth of one kind or other there was ordered 194 million yards, or 175 times the average. The goods are chiefly such as can be depended on to wear out under the conditions of warfare at a faster rate than the blankets, for example, of which 19,800,000 had been placed on order. It is common knowledge that the hosiery industry had been substantially commandeered, and up to March 31 there had been ordered over 54¼ million pairs of socks, 23 million drawers, over 8¾ million vests, and 7½ million cardigans and jerseys. The figures are large enough to stimulate curiosity as to what will happen when the war stops, and upon what contracts we may rely in years to come.

The Council of the Institution of Mining and Metallurgy has invited representatives of the industries other than those of coal and iron to attend a private meeting to be held at River Plate House on Tuesday next, the 8th inst., to discuss the question of the excess profits tax. Since October last the Institution has been in communication with the Chancellor of the Exchequer with a view to effecting an adjustment of the incidence of the tax on the basis of a recognition of the principle that mines are wasting assets and that profits of mining enterprises should be regarded as in a large measure amortization of capital. This principle applies particularly to gold mines, the profits of which, moreover, have been seriously affected by reason of the fact that while the price of gold is fixed, the cost of labour, machinery, freight, and supplies is not fixed, but has greatly increased. The Institution has reason to believe that these circumstances will be taken into full consideration by the Board of Referees appointed under the Finance Acts, to whom the Institution proposes to submit an appeal on behalf of the mining industry generally. Resolutions will be submitted to the meeting dealing with the procedure in regard to the appeal, and appointing a committee of twelve to act with the Council. The circumstances of mining are such that a more equitable and satisfactory solution should be obtained by an appeal made through such a body as the Institution than by individual applications; it will also save time.

The Ministry of Munitions states that Mr. Henderson's Committee, after consultation with representatives of workmen and employers, has made the following recommendations regarding the extra rates of wages to be paid to all munition workers for work during holiday time :—

1. *Where Agreements Exist.*—Workmen employed on any holidays in August or later (including August Bank Holiday) in respect of which there are standing customs or agreements for the payment of special rates, shall be paid at such special rates. This to be understood subject to the fact that where special rates of pay have already been given in respect of days of holidays already postponed, no further special rates shall be paid on any further postponement of the holidays.)

2. *Where no Agreement Exists.*—(*a*) Where August Bank Holiday has been a recognised holiday, workmen employed on that day will be paid at a rate of a quarter over and above the rate for all the hours worked, including the existing rates and allowances for overtime and night shift. (*b*) Where Whit Monday has been a recognised holiday, workmen employed on Tuesday, August 8 (the day substituted for Whit Monday), that day will, in the case of firms which worked but did not pay special rates on Whit Monday, be paid at a rate of a quarter over and above the rate for all the hours worked on August 8, including the existing rates and allowances for overtime and night shift.

These recommendations have been accepted and instructions have been issued accordingly to all controlled establishments. It is hoped that uncontrolled establishments engaged on munitions work will fall in, as far as possible, with the recommendations.

As regards such uncontrolled establishments undertaking work for the Ministry of Munitions, Admiralty, or War Office, those Departments will be prepared to consider cases where clear hardship arises owing to the extra expenditure involved in paying enhanced wages in respect of postponed holidays.

On the invitation of the Joint Committee of the Birmingham University and the Workers' Educational Association, says the *Birmingham Daily Post*, Mr. Percival Bower (Chairman of the Birmingham Engineering and Allied Trades' Federation) delivered a lecture at the University on Tuesday last.

Following a *résumé* of the history of the trade-union movement, Mr. Bower dealt with the nature of the rules which the unions had relaxed, showing that they were real sacrifices and certainly not so hypothetical as certain sections of the public assumed they were. Considering how far it was possible or desirable to restore the trade-union rules to the position they occupied before the war, he stated that few expected to see the old order of things obtain upon reversion to something like the normal position. He was not sure the lessons of the war could not be best applied by both sides meeting round the table and drafting conditions which would perhaps suit better the new order and the changed circumstances with which we should be confronted.

A meeting of delegates of the South Wales miners was held in Cardiff last Tuesday to consider the Admiralty appeal for the postponement of the August holidays. The owners, as an inducement, had offered 1*s.* a day extra to each operative above 18 years of age, and 6*d.* a day extra to each boy under 18, provided a full week was worked. The meeting was presided over by Mr. James Winstone, who appealed to the men's loyalty and patriotism. He referred to the pledge given by the owners and operatives to secure the greatest possible output of coal during the period of the war. The executive unanimously recommended the men to refrain from taking holidays. Ultimately card voting took place, each card representing 50 miners. The result was: for taking two days' holiday, 68,300; against 63,200; majority for, 5,100.

The Minister of Munitions announces that 124 additional establishments have been declared controlled establishments, making the total now 4,052.

In a memorandum drawn up by the War Office to show the general state of affairs at the beginning of the third year of the war it is stated that where, in 1915, the output of munitions was restricted to a comparatively small amount the organisation of men and machinery now enables us to turn out more than sufficient supplies for our enormously increased army, and also to render assistance to our Allies. March, 1916, marked the introduction of compulsory service in England; but before that date 5,041,000 men had joined the forces voluntarily. At present Great Britain has at her disposal the services of the whole manhood of the nation, as well as the contingents raised in India and the Overseas Dominions. At the close of the second year of the war the amount of enemy territory in the occupation of the Allies is 2,775,300 sq. km. (1,071,000 sq. miles), whilst the Central Powers can only claim a total of 431,000 sq. km. (167,000 sq. miles) of territory belonging to the Allied Powers in their occupation.

Metric Measurement Conversion Tables.—A table for the conversion of metric lengths to feet and inches is published by Redvers Elder, 23, Radnor-street, Glasgow, W., at the price of 1*s.* A table on the same principle for converting kilogrammes to avoirdupois is also published at the same price.

American Manganese Imports.—The imports of manganese ore into the United States in April were 48,413 tons; this was the largest total for any one month this year, and brought the average to May 1 up to 24,989 tons per month, as compared with 26,731 tons per month in the corresponding period of 1915, and 28,757 tons per month in the corresponding period of 1914. The aggregate imports for the ten months ended April 30 this year were 355,795tons, against 159,203 tons, and 242,748 tons.

Blowing-up Damaged Buildings.—The severe fire which ravaged the town of Bergen last January necessitated the blowing up of the damaged houses. For this purpose a company of the Norwegian Royal Engineers was placed at the disposal of the municipality, and in the course of a fortnight the engineers blew up some 60 houses. Dynamite was used in most cases, guncotton in a few instances where it was considered risky to employ dynamite. The charges were generally placed about the level of the surface of the earth and detonated by electricity. For a two-brick wall charges of dynamite, according to the size of the house, varied from 0.25 to 0.50 kilogramme, and the distance between the charges from 1 to 1.5 metres. The houses, as a rule, were lifted right up and fell straight down, the walls not falling to either side.

THE PHYSICAL SOCIETY OF LONDON.

AT the meeting of the Physical Society of London, held on June 30, 1916, at the Imperial College of Science, Professor C. V. Boys, F.R.S., President, in the chair, a paper, entitled "*A Sensitive Magnetometer*," by Dr. P. E. Shaw and Mr. C. Hayes, was read by the former.

A torsion balance of extreme delicacy carries a pair of purest silver balls, each 3 gm. weight. A solenoid with horizontal axis passing through one of the silver balls is brought close to the balance. On exciting the solenoid, divergent fields of known strength are obtained in the region of the ball. The resulting attraction of the ball to the solenoid is shown by a mirror reflecting a distant scale to a telescope. The couple on the torsion beam required to produce 1 mm. scale deflection is 4.5×10^{-7} dyne cm., and this torsion balance is 10^6 times as sensitive as any known to have been used previously in this kind of work. The results of these experiments are :—

1. The magnetic properties of the silver are ascertained even for weak fields of 1—10 gauss.

2. The silver has a pronounced retentivity, this effect being presumably due to the small trace of iron impurity.

3. The relation of susceptibility of the silver to the field used is found. The susceptibility of each of the constituent materials, (*a*) pure silver, (*b*) residual pure iron, appears to be greatly modified by the presence of the other material.

Discussion.—Dr. S. W. J. Smith thought that the results obtained by the authors, showing the susceptibility of nearly pure silver in weak fields, were both interesting and instructive. He thought the authors, in discussing their significance, had overlooked the fact that the minute amount of iron (not exceeding 30 parts per million) shown to be present by chemical analysis, would not have the same effective susceptibility as iron in the form, for example, of long rods magnetised in the direction of their length. It was true that iron, when alloyed with other substances, could lose its characteristic ferromagnetic properties; but there was no reason to suppose that it would do so when present in silver, except in so far as the properties of a very minutely divided substance might differ from those of the same substance in bulk. So far as he knew, iron and silver were mutually insoluble. In that event the impurity found to be present should be regarded as minute particles of iron scattered about in a matrix of silver. To obtain an approximate idea of the effect of these particles upon the susceptibility of the material as a whole, it would be sufficient to regard them as spheres. Since the apparent susceptibility of a sphere is equal to $K/(1 + 4/3\pi K)$, where K is the true susceptibility, and since the true susceptibility of iron in weak fields is considerable, the apparent susceptibility of such spheres would be practically constant in weak fields and equal to $3/4\pi = 0.24n$. Hence, if the fraction of the total volume occupied by the iron were $n \times 10^{-6}$, the observed susceptibility of the material would be of the order $K_a = (0.24n - 2)10^{-6}$, where -2×10^{-6} represents the susceptibility of the silver. It was found by the authors that the susceptibility was practically constant over the range H = 4 to H = 12 c.g.s., and approximately equal to 0.25×10^{-6}. This would agree with $n = 9.4$. In other words, the results would indicate that the amount of iron present as impurity was of the order 10 parts per million (by volume). The curves given by the authors seemed to show that the apparent susceptibility varied considerably in fields lower than H = 4; but part of the appearance of variability was due to the fact that, by inadvertence, the curves had been made to pass through $K_a = 0$ at H = 0. A possible source of uncertainty in the measurements in the weaker fields was the relatively great importance, under these circumstances, of P, the (assumed) permanent magnetism of the sphere. It seemed unlikely that the value of K for the iron in the weaker fields would be such as to make the effective susceptibility much less than $3/4\pi$, although there would be some tendency in this direction. The conclusion which he would draw from the data would be that the magnetic analysis of the material agreed with the chemical analysis and supported the inference, from other experiments, that iron and silver are mutually insoluble. The results obtained in strong fields (by Honda and others) did not, as the authors suggested, conflict with this conclusion, but confirmed it. The diamagnetic susceptibility of silver probably remains constant as the field strength is increased (within experimental limits); but, in intense fields, the susceptibility of iron is small compared with $3/4\pi$. For instance, in fields of the order 25,000 c.g.s., the value of K may be of the order 0.1 to 0.05. Taking the latter figure, the effective susceptibility of the iron spheres would be approximately 0.04. The observed susceptibility of the material as a whole would be of the order $K_a = (0.04n - 2)10^{-6}$. Hence, assuming the value of n already deduced, we should expect K_a to be of the order -1.6×10^{-6}. Therefore, we should expect that the material used by the authors would become diamagnetic in strong fields; that it would, in fact, behave in such fields like the silver, of similar purity, examined by Honda.

Dr. Chree said it was of the utmost importance in working with weak fields to get rid of effects due to electric tram and railway systems. This was not an easy matter nowadays. He had expected to hear some reference to the bearing of these results on Dr. Shaw's gravitational experiments, and would like to know if the magnetic experiments had caused any modification in Dr. Shaw's conclusions on the effect of temperature on gravity.

Professor Boys said that in his own experiments on gravitation and also in the design of the radio-micrometer, the magnetism of impurities had always to be considered. The magnetic forces involved are so minute, that in most instruments—galvanometers, for example—they are ignored. In the radio-micrometer the field that could be employed was limited by the magnetism of the purest copper that could be obtained. He had drawn some copper himself which, after being cleaned with acid and gilt to protect it from air, had worked very satisfactorily. In the case of his gravitation experiments, he had used gold balls, of the greatest purity the Mint could supply, cleaned with nitric acid. No consistent magnetic disturbances were detected on moving a permanent magnet about in their neighbourhood.

Dr. Shaw, replying for the authors, was gratified that Dr. Smith's calculations had confirmed their numerical results. His theoretical treatment had been very instructive, and had enlightened them on several important points. He would like to ask Dr. Smith if superposition of magnetic properties would still occur in the case of two mutually soluble metals?

Dr. Smith: In general, no.

Dr. Shaw, continuing, said, in reply to Dr. Chree, that in order to test whether the magnetic force between the large lead spheres and the silver spheres would vary appreciably with temperature in the gravitational experiments, he had inserted an iron bar in one of the lead spheres, but even then he had been unable to detect any variation in the force exerted on the silver when the lead and its contained rod were heated to 200 deg. C. Since the magnetic material in the lead was very much less than this in the actual gravitation experiments, it was certain that the results were not affected by thermo-magnetic phenomena.

A paper, entitled "*The Latent Heat of Fusion of a Metal, and the Quantum Theory*," was read by Dr. H. S. Allen. In this paper a criticism is given of a theory of the process of fusion recently put forward by Ratnowsky. The author of the theory obtains an expression on certain assumptions for the entropy of a substance in the solid state. He then proceeds to deduce a simple formula suitable for use at high temperatures. It is shown that this formula is incorrect in consequence of the omission of a term in the expansion. Assuming, with Ratnowsky, that the entropy of the liquid state can be calculated in the same way as that of the solid, a corrected expression is deduced for the atomic heat of fusion which is equal to the difference between the entropies multiplied by the temperature of the melting point. Ratnowsky, taking the values of the atomic heat of fusion determined experimentally, calculated the ratio of the "characteristic temperatures" for a number of metals, and came to the conclusion that the ratio is approximately constant. The values have been recalculated by the corrected formula, and it is found that they are far from constant. The ratio calculated for mercury by an independent method does not agree with the conclusion of Ratnowsky.

Some experiments on the thermo-electric properties of fused metals were shown by Chas. R. Darling, A.R.C.S., Lecturer in Physics, Finsbury Technical College.

The experiments shown related to observations made during the progress of a research, having for its object the production of a thermo-electric pyrometer with a liquid element. If such a pyrometer could be made of suitable materials—such as graphite and molten copper—it might be possible to extend the useful range of base-metal pyrometers up to or beyond the melting point of platinum, as the boiling point of copper is 2,310 deg. C.

In seeking a satisfactory couple, experiments were first made with molten tin in the following manner: An iron crucible was inserted in a hole in a sheet of uralite, so that its rim was flush with the upper surface of the sheet. A groove was made in the uralite, commencing at the crucible, and the molten metal was then poured into the crucible until it overflowed, and then along the groove, at the end of which a cold junction was formed with the second metal. A wire dipping into the crucible formed the hot junction; and by this arrangement a continuous circuit was maintained between the liquid in the crucible and the solid in the groove. Advantage was taken of this arrangement to observe the effect of fusion on the E.M.F. developed, about which little information appears to exist.* It was noted that when tin was partnered by iron, nickel, copper, constantan or graphite, no abrupt change occurred at fusion, the E.M.F.-temperature curves showing no break. Using iron and tin in this manner forms an instructive lecture experiment. Starting from the cold, the E.M.F. rises steadily; remains constant during fusion at 232 deg., and then rises to a maximum at 340 deg., after which inversion takes place—the whole change occupying only two or three minutes when a small crucible is used.

On substituting lead, zinc and bismuth in turn for tin, and using a variety of wires, it was again found that the change of state caused no alteration in thermo-electric properties. In the case of bismuth, however, three instances of thermo-electric "halt" were noticed, the E.M.F. attaining a maximum and then remaining unchanged over a considerable range of temperature. An iron-bismuth couple reaches a maximum of about 18 millivolts at about 250 deg. C. (M. Pt. of Bi = 269), which remains constant to within 3 per cent. up to 550 deg., beyond which it has not been investigated. Copper and bismuth behave in the same manner, the E.M.F. being practically the same as in the former case; whilst aluminium and bismuth furnish a third example, the E.M.F. (about 15 millivolts) being remarkably constant over a range of 300 deg. A previous instance of this kind was observed by Barrett with a couple of pure iron and an Fe-Ni-Mn alloy.

A suggested form of liquid-element pyrometer was described, and it was suggested that the experimental methods shown might prove useful in the thermal investigation of alloys, as the formation of definite compounds would probably be accompanied by a notable change in E.M.F. The steady E.M.F. furnished by the Bi-Al couple might also be used in work in which a constant, low E.M.F. was required.

Discussion.—Dr. S. W. J. Smith asked if there was any possibility of a chemical action occurring between the elements as the temperature increased, and so modifying the properties of the junction as to bring about the thermo-electric halt observed in some of the couples.

Professor C. V. Boys thought that the property must be peculiar to the bismuth, otherwise the same class of phenomenon should be obtainable with combinations of the other elements, iron, copper and aluminium. This, of course, is not the case.

Dr. Shaw asked if Mr. Darling had used the same quantity of bismuth over and over again to see whether the results were affected by contamination.

Dr. Borns asked if the results were repeated exactly on every occasion.

Mr. Whipple thought these bismuth junctions might prove very useful sources of small constant E.M.F. for calibration purposes in works, &c.

Mr. Darling did not think the thermo-electric halt was due to chemical action. He would like to do much more work on the subject before attempting an explanation. He had used the same bismuth many times, and the results were always the same.

A paper, entitled "*Cohesion*," Part II., by Professor H. Chatley, was taken as read.

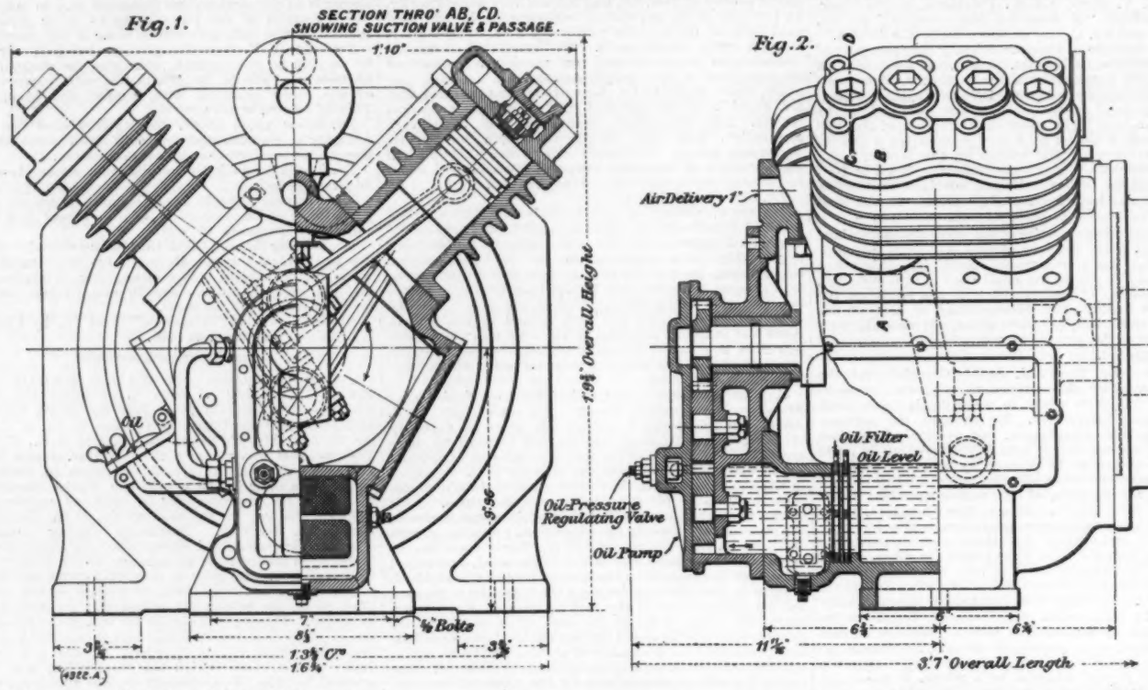
* See paper by Porter and Simeon, Proceedings of the Physical Society of London, June, 1915.

THE LATE COLONEL SIR WILLIAM SINCLAIR SMITH BISSET.—We regret to have to announce the death, which occurred last Sunday, July 30, at his residence, Hill House, Stoke Poges, at the age of 73, of Colonel Sir William Sinclair Smith Bisset, late R.E., K.C.I.E. The deceased was a son of the late Rev. James Bisset, D.D. He entered the Royal Engineers in 1863, and three years later joined the Public Works Department in India. He superintended in 1870 the survey which prepared the way for the construction of the Darjeeling-Himalayan Railway. Becoming deputy consulting engineer for guaranteed railways in the Calcutta circle in 1872, he served later as manager of the Holkar State Railway, on special duty in connection with the Madras famine relief works in 1877, and then in the Afghan War, where he gained the medal and the brevet rank of major. Thereafter to 1893 he was first manager of the Rajputana Malwa Railway, and then agent and chief executive officer of the Bombay, Baroda and Central India system, with which the former line was incorporated in 1884. Subsequently he was appointed acting Director-General of Railways, and later he was given the post of Secretary to the Government of India, Public Works Department. He filled it until 1897, when he was knighted, and returned to this country to become Government Director of Indian Railways. He retired from the India Office in 1901 on election to the chairmanship of his old company, the Bombay, Baroda. Sir William was also chairman of the Madras and Southern Mahratta Railway.

GOVERNMENT ASSISTANCE TO BRITISH COLUMBIAN SHIPBUILDERS.—In British Columbia a measure to assist shipbuilding has been adopted by the Legislature. The Act, says *The Times*, establishes a shipping Credit Commission with power to lend money for the construction of vessels. The Board will borrow through the Government and lend to builders at 6 per cent. interest. The loans will run for five years, and each year one-fifth of the principal must be repaid. Each loan will be limited to 55 per cent. of the value of the vessel, which must be registered in British Columbia. The Commission will take a first mortgage on the whole value of the vessel, which must also be insured in favour of the Commission. Until the money is repaid the Commission will be managing owner, and the ship must trade in British Columbia. The cost of the Commission is provided by a reserve fund of 1 per cent. of the gross earnings of all subsidised vessels. Under the terms of the Act the Government can lend 400,000*l.* without consulting the Legislature, but for any greater amount legislative sanction is required. The plans and specifications of all vessels must be approved by the Commission, only white labour may be employed in construction, no vessel may be sold or transferred for five years without the consent of the Commission, and every charter must be approved. It is further provided that no vessel subsidised may charge higher freight rates than prevail for similar commodities in the State of Washington. This is designed to redress existing inequalities in freight charges. It now costs 4*s.* a ton more to ship lumber from the ports of British Columbia than from those of Washington. Other clauses of the Act apply to new vessels built through loans from the Commission or otherwise. Twenty vessels may be bonused to the amount of 1*l.* a ton per year for 10 years, but this provision is applicable only after the war, when earnings may be reduced. No ship earning 15 per cent. interest for the owners may be bonused, but for a 10-year period after peace is declared the Commission may meet any deficiency between a ship's earning capacity and 15 per cent. of actual cost. The object here is to ensure continuous trading from British Columbia. Another section of the Act guarantees 55 per cent. of the actual cost of shipbuilding plants for construction and repair of vessels. The guaranteed rate of interest on bonds of such companies is fixed at 6 per cent., but actually British Columbia guarantees only 2 per cent. additional to 4 per cent. guaranteed by the Dominion Government. There was severe criticism of the measure as unlikely to produce results and as unwise in consideration of the financial position of the province. But the necessity for exceptional action to increase shipping in British Columbian waters is not disputed. Already under the Act five vessels are in course of construction—three in Vancouver and two in Victoria—and other contracts are pending.

AIR-COMPRESSOR FOR BRAKES ON ELECTRIC RAILWAYS.

CONSTRUCTED BY MESSRS. BROOM AND WADE, LIMITED, ENGINEERS, HIGH WYCOMBE.



On this page we illustrate a four-cylinder air-compressor for supplying air to operate the brakes on electric trains; such machines are used in large numbers on the Metropolitan District and other electric railways. The machine in question delivers 35 cub. ft. of air per minute at 80 lb. pressure, and weighs 8¼ cwt. It will be noticed that the compressing cylinders are air-cooled, and that the four pistons are driven from two cranks, the cylinders being disposed in pairs about 90 deg. apart. These machines have to run for considerable periods without attention, and therefore special consideration has been given to the lubrication arrangements. The oil capacity is sufficient for a three weeks' run. There is an oil pump driven by a pinion on the end of the crankshaft, and drawing from a sump in the base of the casting. It delivers through a pipe into one of the main bearings, and thence the oil makes its way through holes drilled in the crankshaft to the other bearings before dripping into the main casting. A filter is interposed between the body of the casting and the suction sump.

The compressor is driven by an electric motor, and has a guaranteed efficiency of 87 per cent. The makers are Messrs. Broom and Wade, Limited, of High Wycombe.

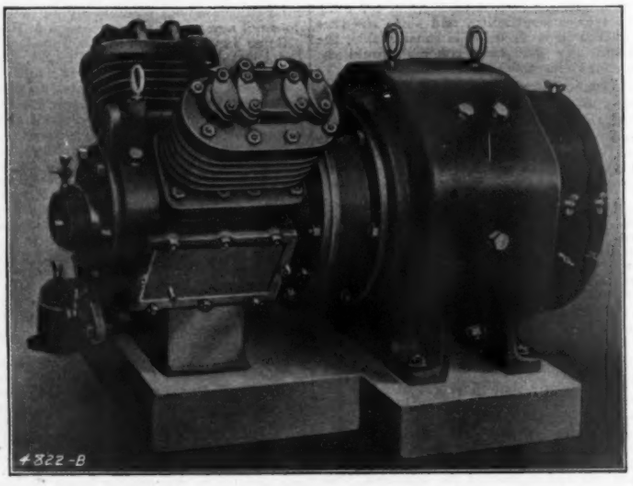


Fig. 3.

SALVAGE OF THE JAPANESE ARMOURED CRUISER "ASAMA."

We reproduce on the opposite page and page 106 the illustrations which accompanied an interesting paper read at the meeting of the Japanese Society of Naval Architects at Tokyo, on April 10 last, by Captain M. Iwano, Captain T. Urata, and Commander Y. Hashiguchi (all Constructors in the Imperial Japanese Navy), dealing with the salvage of the armoured cruiser Asama, which went ashore on the rocks at the entrance of the Gulf of San Bartolomé, Turtle Bay, South California, Mexico.

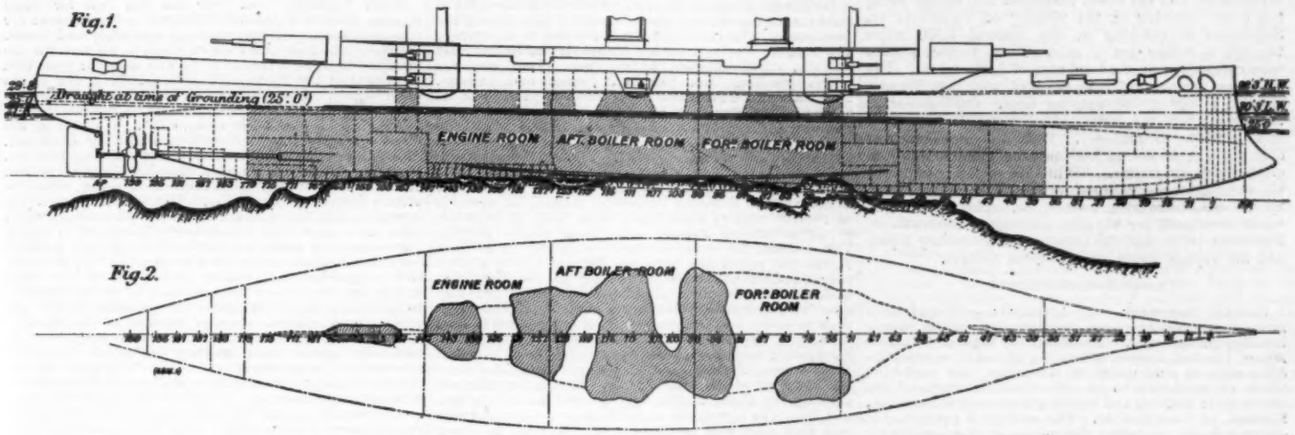
The Asama was constructed at the Elswick Yard of Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, and was completed in 1899. She is an armoured cruiser, 408 ft. long, 67 ft. beam, and has a displacement of 9,885 tons when drawing 24½ ft. of water. Her armament consisted of four 8-in. guns, fourteen 6-in. guns, and twenty lighter guns. Her speed on trial was 21·1 knots with 19,000 h.p.

The Asama went aground on January 31 of last year, and her position on the rocks is shown in Fig. 1 on the opposite page. Examination proved that she was flooded throughout her length to the level of the protected deck, with the exception of those parts forward and aft unstippled in Fig. 1. She was resting on six projecting rocks in a position exposed to all changes of weather, and at low water her draught was 21 ft. The damage above water was slight, but the bottom of the vessel had a series of holes made by the rocks, as shown in the plan, Fig. 2. In the forward boiler room, on the starboard side, there was a hole 25 ft. long, but the largest opening was an irregular tear under the forward boiler room, throughout the aft boiler room, and in the engine room, the length being 80 ft. The inner bottom in this case was forced upwards throughout most of its length, the maximum height being 2 ft., while the holes had a maximum length of 30 ft. The bulkheads in this damaged portion were severely buckled at their base, as is shown in the cross section, Fig. 4, on page 106. This bulkhead is that which separates the after boiler-room from the engine-room, and on the same page there are reproduced (also from the paper read at Tokyo) detailed drawings, showing the construction of the several brackets connecting the bulkheads with the inner bottom, and the construction between the inner and outer bottom, and at various points with the boiler seating. Each bracket thus illustrated is identified with its position in the ship by the lettering shown on the cross-section, Fig. 4. The bulkhead stiffeners are similarly illustrated and identified. The quality of steel in the structure was stated in the paper to be obviously good, and the cracks formed "were comparatively not numerous."

Temporary pumps were brought from Japan, six of large capacity, and several of smaller power, in addition to pulsometers. These pumps were supplied with steam from boilers temporarily installed on the upper deck, the pumps themselves being located on the protected deck below. The total capacity of the pumps was 6,750 tons per hour. The salvage operations were commenced in April, 1915, the two after 8-in. guns with their ammunition having been removed. The long tear in the bottom under the forward boiler-room was covered by steel plates formed from templates taken by the diver. Other rents were dealt with in a more temporary manner. The hatches in the middle deck were also increased in height, in order to keep the upper part of the ship free from water when the tide rose. Large canvas sheets were also held in readiness to cover over holes as the ship lightened. The pumping proved fairly successful at the forward end of the damaged part of the ship, but was less so aft. It was found that much water entered the machinery spaces, but nevertheless the pumps obtained an advantage to the extent of 1700 tons of water per hour, showing that the influx was still 5,000 tons per hour. There was no rush of water anywhere, which further proved that the damage to the bottom was spread over a wide area.

A general plan of operations was devised as a

THE SALVAGE OF THE JAPANESE ARMOURED CRUISER "ASAMA."



FIGS. 1 AND 2. LONGITUDINAL SECTION AND PLAN TO SHOW VESSEL ON THE ROCKS AND DAMAGE TO BOTTOM.

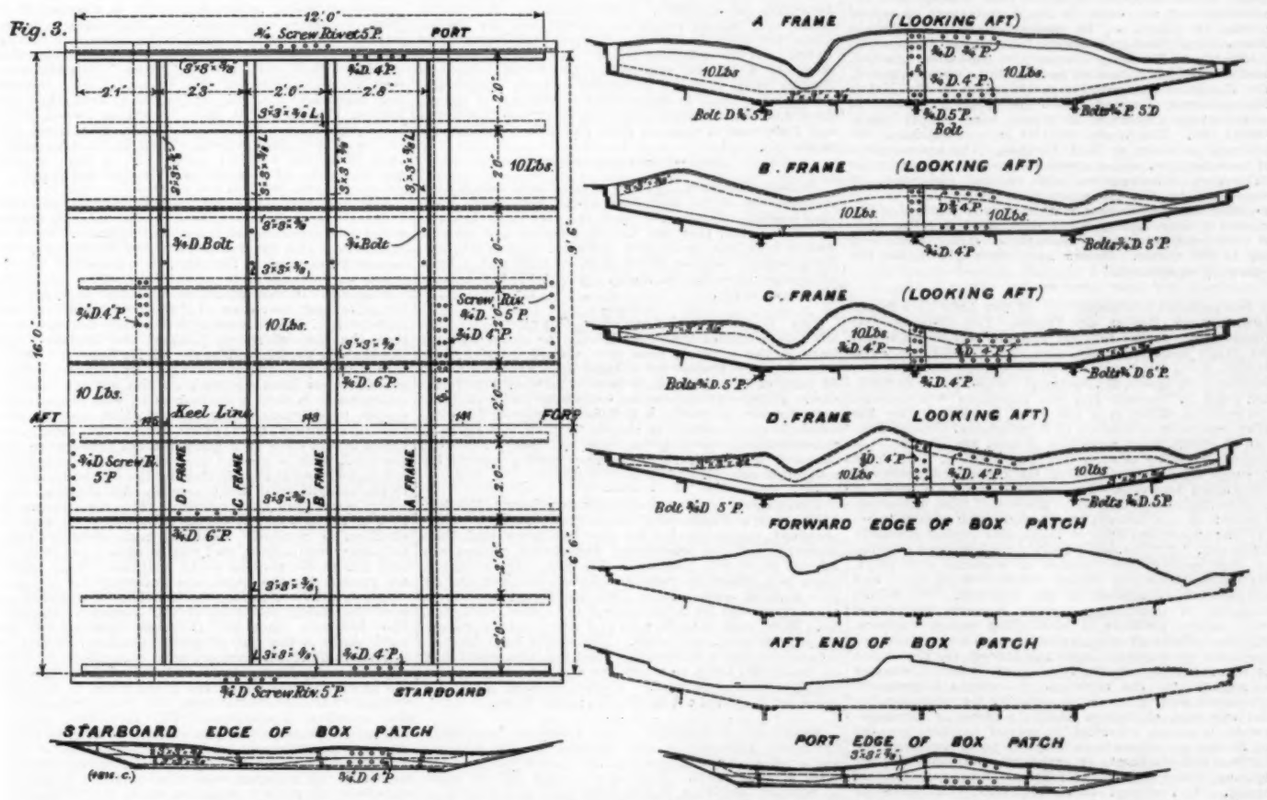


FIG. 3. DETAILS OF BOX PATCH FITTED OVER HOLE UNDER THE ENGINE COMPARTMENT.

result of this preliminary work, and, later, the incoming flow of water was reduced to 4,600 tons per hour, and still later to 3,400 tons. Calculation on this basis proved that with the foremost compartment full and 11 ft. of water in the next compartment the ship could be floated. Floating was therefore effected on May 8, and the ship towed off the rocks. Canvas mats had been applied to reduce the influx of water. Three pumps were then sufficient to keep the water to a level not exceeding 2 ft. over the inner bottom. It was then possible to make a fuller inspection of the damage done, and it was found that in the fore boiler-room the inner bottom was forced upwards an average of 1 ft., the floor plates being much bent over, while the bulkhead between the two boiler-rooms was damaged. In the after boiler-room the inner bottom was up to an extent of 3 ft. or 4 ft.; at one point the plating of the inner bottom was torn very considerably. The centre line bulkhead through the boiler-rooms was buckled at the bottom, and the transverse bulkhead between the after boiler-room and the engine-room was separated from the inner bottom. The damage in the engine-room was not so severe, but the centre line of the engines was much out of truth, and there were many holes in the outside plating.

After the ship had been floated off the rocks the work of providing for the exclusion of water was continued. Blankets were wrapped over the openings more thoroughly than had been previously possible with the canvas, 6-in. wide battens being utilised, and these were held in place by wire ropes encircling the ship. The damage to the inner bottom was repaired in order to prevent danger from suction while more permanent work was being executed on the outer shell. Flanged plates were used, fortified by cement, to connect the bulkheads with the inner bottom, and new stiffeners, where necessary, were introduced on the bulkheads.

The most interesting part of the work, however, was the fitting of box patches, built up of plates and angles, to the outside shell where seriously damaged. These box patches varied according to the size of the hole to be covered. In one case the length was 36 ft., in another the dimensions were 23 ft. 8 in. by 24 ft. 9 in., and in a third—that under the engine-room—the dimensions were 16 ft. by 12 ft. This last-named box patch is illustrated on this page, on which are a plan and cross-sections at the various frames or stiffeners, the forward and aft edge, and the port and starboard sides. The details of the construction will readily be understood by reference to the drawings reproduced from the paper.

These boxes having been put in position, the ship's own pumps were brought into action to keep the machinery compartments dry, while repairs to the machinery were commenced on June 21 and completed on August 10, sufficiently to enable the vessel to proceed under her own steam. To avoid risk of pressure on the inner bottom, rough coamings were built around the manholes, and the salvage pump suctions were carried down through these. The ship left San Bartolomé on August 23, arriving in three days at another port along the coast. The outer bottom was there carefully

examined, to ascertain how the temporary repairs had stood the passage along the coast. This was found to be satisfactory, and the vessel continued her voyage along the coast, arriving in the vicinity of Vancouver on September 4, covering in the interval 1,500 miles through a rather heavy gale. There further repairs were carried out over a total area of 1,044 sq. ft. The incoming flow of water to be dealt with was thereby reduced to 600 or 700 tons per hour. On October 23 the Asama left the coast, and arrived at a port in mid-Pacific on December 7. There a serious crack was discovered in the second low-pressure cylinder crank-pin on the starboard engine. While this was being repaired, the watertightness of the ship was still further improved by the use of sawdust, wedges, &c. The vessel afterwards continued her voyage, arriving at Yokosuka on December 18, so that the salvage, the temporary repair and the voyage lasted almost eleven months.

Copper Industry in Australia.—Considerable interest attaches to recent developments in the copper industry in Australia. The Hampden Cloncurry Copper Mines, Limited, instead of sending its metal overseas for conversion to pure metal, as heretofore, now sends the whole of its output to be refined at the works of the Electrolytic Refining and Smelting Company of Australia, Limited, at Port Kembla. The refinery is not yet able electrolytically to refine the whole of the company's output, and the excess is pre-refined, and is being disposed of at satisfactory prices. An interesting paragraph in the directors' report is that dealing with the establishment of works for the manufacture of copper goods, as follows:—"In association with the Mount Morgan Gold-Mining Company, Limited, the Electrolytic Refining and Smelting Company of Australia, Limited, and the British Insulated and Helsby Cables, Limited, the Hampden Company is participating in the Metals Manufactures, Limited. This company is formed to manufacture all classes of copper wire, copper tubes, sheets, &c. The works will be situate adjoining the electrolytic works at Port Kembla. The consumption of manufactured copper goods is a growing one, and after exhaustive investigation, and on the assurances of support from the Commonwealth authorities, we are satisfied its inauguration is commercially justified. The capital of the company is 200,000*l.*, of which a first issue of 60,000 shares has been made, the company subscribing for 15,000 shares. Orders have been placed for the necessary equipment."

Departmental Committee on the Iron and Steel Industries; Board of Trade.—The Departmental Committee consists of:—Mr. G. Scoby Smith, Chairman, Sir Hugh Bell, Bart., Mr. Archibald Colville, Mr. John Hodge, M.P., Mr. James Gavin, Mr. George Mure Ritchie, Mr. Henry Summers, Mr. Benjamin Talbot, Mr. John King, Mr. John E. Davison and was appointed "to consider the position of the Iron and Steel Industries after the War, especially in relation to International Competition, and to report what measures, if any, are necessary or desirable in order to safeguard that position." In order to carry out its investigations, the Committee desires to elicit exact and detailed information from a number of representative and individual firms, and from industrial, commercial, and labour organisations, with respect to:—(1) The extent and area of trade, and capital normally employed. (2) The dependency upon resources external to this country for supplies of material and plant. (3) Labour relations, labour restrictions (if any), and comparative conditions in the industry. (4) British methods of conducting foreign business contrasted with foreign methods of conducting export business. (5) The effects of manufacturing and commercial co-operation upon trade at home and abroad. (6) The extent to which British industry is adversely affected whether as regards (a) the retention of business hitherto or previously secured, or (b) its capacity for expansion, by the existence of foreign tariffs, preferential arrangements, bounties, subsidies, or special facilities granted by foreign governments, railways, or trade combinations, to their manufacturers or exporters; and what, in your opinion, is the remedy. (7) Terms of payment and of credit. (8) Technical education, skill, and nature of employees. (9) The effect, if any, of wayleaves, and mining or other royalties upon the industry, either as regards home or export trade. (10) The effect, if any, of railway and shipping rates upon the industry, as regards home, or export trade. (11) General information. The recommendations of the Committee must depend for their effectiveness upon the co-operation of all who are interested in the British Iron and Steel Industries. The Committee, therefore, invites the active support and assistance not only of individuals, but also of industrial organisations of whatever character. The Committee suggests that the various trade organisations should submit either through their Secretaries or through small Committees, a general statement of their views together with suggestions which in their opinions might desirably form the foundation of practical measures in the future. The general evidence might suitably be supported by the presence of a deputation representative of the organisation as a whole. The Committee will be glad to receive statements supported by verbal evidence from representative firms, and from individuals, whose depositions, in the opinion of the Committee, will be valuable to their work. It will also welcome the assistance of import and export merchants who are interested in the handling of the products of the Iron and Steel industries at home and abroad.

NOTES FROM THE UNITED STATES.

Philadelphia, July 19.

Domestic demand for steel products outside of soft steel for implement use has been rather light during the past week. The most noticeable activity is in exports. The Russian Government has placed an additional order for rails, approximating 365,000 tons There are large orders pending from England, France and Canada. The Russian Government has succeeded in placing an order for 165,000 tons of barbed wire for trench protection, and other Allied Governments are negotiating for 100,000 tons of wire. In addition, Russia is inquiring for 30,000 cars and 60,000 car axles. France, Germany and Italy are in the market for large tonnages of pig-iron. A concession of 3 dols. per ton on soft steel has brought in orders from domestic implement makers for upwards of 100,000 tons of agricultural steel, with probabilities of an additional 200,000 tons being placed shortly. The demand for structural material, partly on account of extreme prices has cut down the demand to a little over one-half the average. Owing to the fact that demand for munitions, especially shells, will probably soon fall off, munition makers are preparing to transform their capacity into the production of other kinds of steel products. The European demand for pig-iron for steel purposes is very large, reaching within a week to about 100,000 tons, of which about one-fourth will go to France and the bulk of the rest to Italy. French inquiries are pending for about 20,000 tons of steel-making grades, and Canadian buyers are negotiating for a volume of pig-iron that may well reach over 100,000 tons, to which may be added as much as 50,000 tons of Southern foundry grades. The heavy Russian car inquiries has stimulated inquiries for some 300,000 tons of steel from American car-builders. Shipbuilders on the Pacific Coast have placed orders for 10,800 tons for marine plates for three boats. An Eastern yard has ordered 10,000 tons for merchant boats. Japanese shipbuilders at Hong Kong are negotiating for 40,000 tons, and English yards that are permitted to build colliers and refrigerating boats in Japan want 25,000 tons of plates; some 9,000 tons of tank plates will go to the East Indies and 7,000 tons of material for a pipe line in the oilfields of Borneo.

French Helmets.—French armour steel helmets are stamped out of the best sheet steel; four pieces make up a helmet—the cap, the peak, the neck protector, and the crest; and they are riveted together and sprayed with a grey-blue paint, just sufficient to prevent rust. Each helmet requires about 2 lb. of steel and a little aluminium to stiffen the lining. Over 3,500,000 helmets have been made.

The Honourable Artillery Company.—We are officially informed that the H.A.C., the oldest military force in the country, have now opened recruiting for their Artillery Branch for suitable applicants not above 30 years of age, except they have some special qualification. Those with engineering knowledge and experience are especially desirable, and if found suitable for commissions after serving in the ranks they will be duly recommended, especially for Siege and Heavy Artillery, in which at present there are very good prospects for competent officers.

Utilisation of Material from old Goods Wagons.—This, says *Engineering News*, New York, is being practised systematically by the Baltimore and Ohio Railroad, and the mechanical department estimates a salvage of 20 dols. per car in this way. The timber is sawn and planed to remove defective portions and to give suitable sizes. It is then distributed for use in repair work and for building small structures, platforms, &c. Bolts, nuts, wheels, rods and other metal parts are sorted, trimmed and stored. The results have been so satisfactory that a reclamation plant has been established at Zanesville, Ohio, to which are sent all wagons to be scrapped and destroyed. Reclamation of a lighter character is carried out at division repair shops.

American Railroads.—The American Inter-State Commerce Commission has reported on the progress and position of the railroads of the United States at the close of June, 1915. The report covers 257,569 miles of railroad, including 11,279 miles used under trackage rights. The aggregate of all railroad tracks covered by the returns of the various systems at the close of June, 1915, was 371,141 miles, showing an increase of 3,933 miles of all tracks over the corresponding total for the preceding year. The equipment of the lines included in the returns comprised at the close of June, last year, 65,099 locomotives in service, with 2,507,977 cars of all descriptions. At the date indicated the par value of railroad capitalisations was reported to the Commission by the various systems and their subsidiaries at 21,127,959,078 dols., of which 8,994,894,721 dols. was stock and 12,133,064,357 dols funded debt. Of the total capital stock, 3,415,472,806 dols., or 39.55 per cent., received no dividends during the year to which the returns relate; the dividends actually paid amounted to 328,477,938 dols. This was equivalent to 6.29 per cent. on the dividend-paying stock. The average rate last year of dividends on all stocks outstanding was 3.80 per cent. The period embraced by the returns was one of business curtailment and reduced movement of both freight and passengers, as a result of the European war, but a vigorous improvement began to be witnessed in connection with American railroad business in the spring of 1915. The gross revenue acquired by American railroads in 1914–15 was 2,956,193,202 dols.; the working expenses of the year were 2,088,682,956 dols., leaving a net revenue for the year of 867,510,246 dols.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

South Yorkshire Coal.—For the first time for many months there is a distinct easing-off in the demand for manufacturing fuel, particularly for cobbles and slacks. Collieries and merchants are at a loss to account for the unexpected change, though it may be that the periodical stoppages of the Lancashire cotton mills is one of the main causes. Best steams are being freely bought by the railway companies, but outside this branch there is not a great deal of business recorded. Working at the pits is seriously interfered with by a scarcity of wagons. This is due to the uncertainty of the shipping position. Numerous laden wagons have been indefinitely detained at the ports pending the arrival of a vessel, which is often a matter of speculation. The problem is receiving attention, but, as it does not lend itself to a ready solution, some little time may elapse before a remedy is found. The house coal position is good. The superior qualities are in big demand, chiefly for providing the winter stocks. Gas companies are availing themselves of the small inquiry for the inferior sorts on the part of householders to purchase large quantities in preparation for the coming busy season. A large tonnage of this class of fuel is also going abroad. At present no definite action has been agreed upon between the South Yorkshire Coalowners' Association and the Yorkshire Miners' Association on the holiday question. A joint conference, held some few days ago, accepted the general principle of working throughout the holiday season, but the miners desire some "compensation" from the coalowners for the extra hours which will be thereby put in. This point is now the subject of negotiations. It may be settled by the coalowners agreeing to make a grant to the miners' benevolent funds, as has been done in the case of the West Yorkshire coalowners and the miners who met in Leeds yesterday and came to an agreement that the pits should work uninterruptedly throughout the whole of the holidays and the local "feasts." Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.*, 6*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.* per ton at pit.

Iron and Steel.—The raw material position continues to be of outstanding importance, with attention centred round the questions of prices and supplies. Sheffield, in common with the South Yorkshire district generally, is mainly interested in the Derbyshire brands of common irons, and considerable uncertainty exists as to the quotations. It was intimated some few days ago that the price could be advanced if the Derbyshire forge and foundry iron makers were able to satisfy the authorities that the cost of sheets justified the increase. This would make the figures 90*s.* per ton for forge and 92*s.* 6*d.* for foundry, plus cost of delivery. At present no official guidance has been received on the subject, and the consequence is that, with makers as well as consumers unable to determine how the situation may develop, few transactions have taken place. In those cases where orders have been given the old prices have been accepted, with a proviso guaranteeing the makers the advance should it be conceded by the Government prior to the completion of the contracts. On the other hand many large users have refrained from entertaining the idea of doing business on an extensive scale with the situation so involved. Acid and basic steels are scarce and dear commodities, and will be even more so in the near future for general trade purposes. Steel makers are pressed by the munitions authority for increased supplies, but have to face the handicap of irregular and even decreasing deliveries of the necessary materials. The hematite shortage is most pronounced, and particularly in the case of special qualities, despite the fact that additional furnaces have been adapted to this class of iron. The present state of affairs emphasises the great advance which has taken place in enlarging the steel works compared with the progress recorded in the smelting departments. The inevitable outcome will be a further curtailment of supplies of steel for the ordinary manufactures, and the major portion of these will be earmarked for the very important export branch of the trade. If materials were to be obtained in sufficient quantities, Sheffield steelmakers would not be under the necessity of refusing profitable orders for the home market. In regard to the basic steel position, there is reason to believe this presents greater difficulties to consumers than any other department, and the complaint is made that only at prices much above the official maxima can business be done. Good progress is to be noted in the manufacture of special steels for aircraft and submarine engineering. These are of a superior quality, and very expensive. For high-speed steel the demand remains at a high figure, but the output is now much larger than hitherto, for undoubted benefit has been reaped from the use of the electric furnaces. These installations turn out a more even production on a larger scale than the crucible type. The War Office require large numbers of carbon twist-drills, a quantity of high-speed twist-drills, 1,400 pliers, and 4,000 sawyer's wedges. A local tramway firm has secured an order from the London County Council for 750 driving and pony wheels. The full force of the boom in hacksaws and similar productions is being felt in the city, the requirements of the Russian Government alone for hacksaws totalling an enormous figure. All makers report a busy period, and at the present there are several splendidly-equipped works running exclusively on this line. A special factory has been erected to produce the blades, being the forerunner of an extensive movement to render Sheffield independent of outside supplies, both now and in times

of peace. Foreign and colonial business maintains a gratifying level. This week's mail has brought orders for sheep shears, knives, files, wire ropes, steel and cutlery.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Speculative business in the Glasgow pig-iron warrant market remains at a standstill, and the stock of No. 3 iron in store still stands at 1,000 tons.

Scotch Steel Trade.—Nothing could exceed the activity of the steel-making trade in the West of Scotland, and not only is every mill fully employed, but do as they will makers are constantly faced with an ever-increasing amount of arrears which it seems impossible to avoid under the exceptional circumstances. In one way this may be explained by the fact that orders both from our own and the allied Governments keep pouring in, so that there is no chance of getting clear. In particular, pressure for the delivery of steel for shell bars continues unabated, and it is with the utmost difficulty that the mills can turn these out as quickly as they are required. So far as sections are concerned affairs are not much better, these also being in urgent demand; while, except if wanted for war purposes, thin steel plates are practically not to be procured. Little ordinary mercantile business is reported in the home markets, and export, other than war work, is particularly dull, although heavy shipments of all classes of steel required for munitions, &c., are constantly on the road to France and other of the allied countries. Prices keep firm—ship-plates are steady at 15*l.* per ton or thereabouts; boiler plates, 16*l.*; and angles, 14*l.* 2*s.* 6*d.*

Malleable-Iron Trade.—Despite the heavy oncosts, the high rate of labour and the scarcity of regular supplies of raw material, the malleable-iron makers are doing excellent business and easily obtaining the high level of prices ruling at present. Many large contracts are in hand, and new orders for the various products are being booked every day, mainly, of course, for the purposes of war. "Crown" bars for home delivery are still quoted 14*l.* 12*s.* 6*d.* per ton, less 5 per cent.; while for export the price may be 14*l.* 2*s.* 6*d.* per ton and up.

Scotch Pig-Iron Trade.—The trade in Scotch pig-iron of all grades continues to run on most satisfactory lines, hematite especially being in such strong demand that it is impossible to obtain even 1 ton for other than the requirements of the Allies. Every ton of the exceptional output is immediately swallowed up by the local steel-works engaged on Government contracts, and in consequence export is of little account. Prices show a tendency to harden slightly for export orders, but for home business these remain on the level fixed some little time ago. Nothing, meantime, has come of the proposal to restrict the shipments of English pig-iron into Scotland, or of Scotch pig-iron into England, but if anything should be done in this direction it might have serious effect in certain quarters, owing to the dissimilarity of price in the different districts.

Wages in the Scotch Iron Trade.—The joint secretaries of the Scotch Iron Trade Conciliation and Arbitration Board—Mr. James C. Bishop and Mr. James Gavin—have just received from Mr. John M. Macleod, C.A., and issued in the ordinary manner, the following intimation regarding wages in the iron trade:—"In terms of the remit, I have examined the employers' books for May and June, 1916, and I certify the average net selling price brought out is 12*l.* 12*s.* 6.29*d.* per ton. This means an increase of 7½ per cent. in the wages of the workmen."

Engineering Conference in Glasgow.—For the purpose of considering how to maintain and extend the supremacy of British engineers, Lord Provost Sir Thomas Dunlop has summoned a conference of representatives of the leading engineering firms in Scotland to be held in the City Chambers on Friday afternoon. A most gratifying response has been received, and the conference is being looked forward to with much interest. It is expected that Scotland will appoint a very strong committee in every way capable of dealing with the important questions which will undoubtedly call for consideration in a short time, and certainly after the declaration of peace. This committee will act in conformity with similar committees being formed in other industrial centres throughout the kingdom, each one charged with the mobilisation of British manufacturing engineers of all ranks.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—As regards Cleveland pig-iron, the position alters very little indeed. There is continued heavy disproportion between supply and demand, but the Distributing Committee is allocating supplies in a manner which, under the conditions prevailing, leaves little room for complaint. For home use No. 3 Cleveland pig is 87*s.* 6*d.*, and that price also rules for No. 4 foundry and No. 4 forge, while No. 1 is 91*s.* 6*d.* With the exception of shipments to France—which are well maintained—the export trade is inactive, though a licence is reported to have been granted for the insignificant quantity of 20 tons for Norway. For export, 97*s.* 6*d.* is the general f.o.b. quotation of No. 3, but that quality is said to be obtainable for France at 95*s.* No. 1 is in the neighbourhood of 102*s.* 6*d.* for shipment abroad, No. 4 foundry is put at 96*s.* 6*d.*, and No. 4 forge at 95*s.* 6*d.*

Stocks of Cleveland Pig-Iron.—Official returns show that at the end of July the quantity of Cleveland pig-iron in the public warrant stores here stood at only 23,800 tons, composed of 23,430 tons of No. 3 quality, and 370 tons of other descriptions of iron deliverable as standard. There were warrants in circulation for only 9,300 tons, all of which is No. 3. During July the stock was reduced by 4,495 tons of No. 3 and 1,175 tons of standard iron—a total of 5,670 tons.

Hematite Iron.—It is very difficult to arrange any new business in hematite. Makers are sold well ahead and they declare that present cost of output justifies a substantial advance in the fixed maximum price of 122*s.* 6*d.* for Nos. 1, 2 and 3, for home consumption and for shipment to France. No hematite iron is permitted to go abroad except direct through the Ministry of Munitions. The general export quotation for mixed Nos. is from 140*s.* upward.

Blast-furnaces in Operation.—Preparations are about complete for the starting of additional furnaces. One that has been idle for some time is expected to be put into blast this week to make hematite, and this will make the number in operation on the North-East Coast 71, of which 30 will be producing hematite, 28 turning out Cleveland pig, and 13 manufacturing special kinds of iron.

Coke.—At present the supply of coke is slightly more than sufficient to meet local requirements, but with more blast-furnaces going in demand will be greater, and there are rumours that, to cope with the situation, some of the old beehive ovens are to be set to work again. Average blast-furnace coke is 28*s.* at the ovens, and low phosphorus qualities 30*s.* 6*d.* at the ovens.

Foreign Ore.—Continued exceptionally heavy imports of foreign ore on running contracts, and the consequent steady accumulation of the already by no means small stocks, appear to have no weakening influence on quotations. Unloadings at the port of Middlesbrough during July reached no less than 246,877 tons. Rubio, of 50 per cent. quality, is quite 38*s.* ex-ship Tees on the basis of the official 17*s.* Bilbao-Middlesbrough freight, the rate at which controlled consumers are still privileged to arrange for the conveyance of ore, though in the open market the freight is 19*s.*

Manufactured Iron and Steel.—Producers of finished iron and steel continue too busily engaged on Government work to entertain, to any extent, ordinary commercial business. Quotations, all round, are very strong. Common iron bars are 13*l.* 15*s.* to 14*l.* 15*s.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.* to 14*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel ship rivets, 20*l.*; heavy steel sheets (singles), 18*l.* 15*s.*; heavy steel sheets (doubles), 19*l.*; steel hoops, 16*l.* 10*s.*; steel strip, 17*l.*; steel joists, 11*l.* 2*s.* 6*d.*; heavy steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.*

Ironworkers' Wages.—The accountants to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trades of the North of England having certified the average net selling price of iron rails, plates, bars and angles for the two months ended June 30 last at 11*l.* 17*s.* 5*d.*, as against 11*l.* 9*s.* 5*d.* for the previous two months, wages for August and September are, under sliding scale arrangements, advanced 3*d.* per ton on puddling, and 2½ per cent. on all other forge and mill work. Previous to the war the record ascertained price was held in 1913, but the present figure is 4*l.* 5*s.* higher.

Shipments of Iron and Steel.—July shipments of iron and steel from the port of Middlesbrough totalled 73,146 tons, as compared with 91,590 tons for the previous month. Loadings of pig reached 54,311 tons, of which 52,476 tons went abroad, and 1,835 tons coastwise. For June the total clearances amounted to 52,888 tons; whilst for July last year they were returned at 55,933 tons, and for July, 1914, they amounted to 81,687 tons. Clearances of manufactured iron and steel last month are given at 18,835 tons, as compared with 38,702 tons in June. Of this total, 17,960 tons—manufactured iron 1,014 tons and steel 16,946 tons—went to foreign ports; and 875 tons—manufactured iron 700 tons and steel 175 tons—went to coastwise customers. Once more France was by far the largest customer for both pig iron and steel, receiving 44,435 tons of the former and 10,547 tons of the latter. During the previous month 40,449 tons of pig-iron and 27,022 tons of steel went to France.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The steam-coal trade has exhibited a quiet tone. With the position of tonnage unsatisfactory and stocks of coal excessive, buyers have been holding back inquiries in the hope of obtaining concessions. At the same time, quotations for shipments a week forward have been maintained, colliery owners expecting that during August there will be a considerable reduction in outputs through holiday-taking by individual miners. Sellers are also anticipating a heavier demand from British authorities and also from France. The best Admiralty large steam coal has been, to some extent, nominal; secondary qualities have made 35*s.* to 38*s.*; Monmouthshire Black Vein, 37*s.* 6*d.* to 38*s.*; ordinary Western Valleys, 37*s.* to 37*s.* 6*d.*; Eastern Valleys, 35*s.* to 36*s.*; best bunker smalls, 27*s.* to 27*s.* 6*d.*; and cargo smalls, 20*s.* to 22*s.* per ton. In bituminous coal best households have made 25*s.* 6*d.* to 26*s.* per ton at the pits; No. 3 Rhondda large, 37*s.* to 38*s.*; smalls, 29*s.* to 31*s.*; No. 2 Rhondda large, 30*s.* to 32*s.*; and No. 2 smalls, 22*s.* to 23*s.* per ton. The latest quotation for patent fuel has been 50*s.* to 51*s.* per ton. Special foundry coke for export has realised 62*s.* 6*d.* to 65*s.*; good foundry coke, 60*s.* to 62*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

Western Trade Matters.—The Port Talbot Railway and Docks Company has announced an interim dividend at the rate of 9 per cent. per annum upon its ordinary stock; similar distributions have been in vogue since 1913. The Taff Vale Railway Company has announced an interim dividend upon its ordinary stock for the first half of this year at the rate of 3½ per cent. per annum; for the whole of 1911 the stock received 4 per cent.; for the whole of 1912, 3½ per cent.; for the whole of 1913, 4 per cent.; for the whole of 1914, 3½ per cent.; and for the whole of 1915, 3½ per cent.—Interim dividends are announced on the "A" and "B" preference stocks of the Alexandra (Newport and South Wales) Docks and Railway Company; for the half-year ended June 30 the dividends are at the rate of 4½ per cent. per annum. After providing for all prior charges the directors of the Mount Stuart Dry Docks Company, Limited, are in a position to give the holders of deferred ordinary shares in the company a dividend at the rate of 8 per cent. per annum; for the whole financial year 1915–16 the deferred ordinary shares receive 7 per cent. per annum, 28,928*l.* being carried forward.—The death has occurred at Cardiff of Mr. H. Macarthy, resident director of the Cardiff branch of the Fownes Forge and Engineering Company, Limited; Mr. Macarthy, who was 52 years of age, was a native of Newcastle.—The committee formed at Cardiff for shipping coal to France under the proposed limitation of prices and freights system states that steps have been taken to dispense with extensions of licences in cases in which holders of July licences had begun to load coal for France before midnight on July 31. Later shipments will be made under licences for August and September.—The Bristol and South Wales Railway Wagon Company, Limited, has announced an interim dividend at the rate of 10 per cent. per annum.—After providing for excess profits tax, the Hain Steamship Company returns its profits for 1915 at 506,804*l.*, as compared with 303,395*l.* in 1914–15, 139,140*l.* in 1913–14, 340,812*l.* in 1912–13, and 142,048*l.* in 1911–12. The ordinary dividends for the past five years have been: 1911–12, 10 per cent.; 1912–13, 25 per cent.; 1913–14, 10 per cent.; 1914–15, 20 per cent.; and 1915–16, 35 per cent. During the past 12 months four of the company's steamers have been sunk by enemy submarines.—Baldwin's, Limited are about to erect two large modern blast-furnaces at Port Talbot and 100 by-product ovens. The new plant is expected to turn out 400 tons of pig-iron every week.—Further sinkings are taking place at Baldwin's Bryn Navigation Colliery, at Bryn, near Port Talbot.—The ordinary stock dividend of the London and South-Western Railway Company for the past six months is at the rate of 4 per cent. per annum.—The Barry Railway Company announces a distribution upon its ordinary stock for the first half of the year at the rate of 9½ per cent. per annum; for the whole of 1911 the stock received 6½ per cent.; for the whole of 1912, 7 per cent.; for the whole of 1913, 10 per cent. per annum; for the whole of 1914, 9½ per cent. per annum; and for the whole of 1915, 9½ per cent. per annum. At the annual meeting of the Atlantic Trust held at Cardiff on Friday, the chairman (Mr. C. P. Hailey) said the Chancellor of the Exchequer would receive from South Wales a great contribution in respect of the excess profits tax.—Colonel Weiss, French Minister of Mines, visited Cardiff on Friday in connection with steps taken by the British Board of Trade for facilitating and increasing shipments of Welsh coal to France; the measures adopted, Colonel Weiss said, had already relieved the strain of the moment. The Cardiff Railway Company has announced dividends at the rate of 4 per cent. per annum upon its preferred ordinary stock and 3 per cent. per annum upon the deferred ordinary stock.

NEW DRY DOCK IN DENMARK.—The harbour authorities of Aalborg, Jutland, have decided to construct a new dry dock large enough to accommodate most Danish merchant vessels. The cost will amount to about 56,000*l.* The dock is expected to be ready in a year's time, and it will be let to the Stukr shipyard.

TRADE WITH RUSSIA.—We have received from Messrs. R. Martens and Co., Limited, 149, Leadenhall-street, E.C., a copy of an economic map of the Russian Empire which they have issued, showing at a glance the location of the mineral and agricultural resources and the manufacturing centres of our Ally. The map will prove useful in helping trade with Russia.

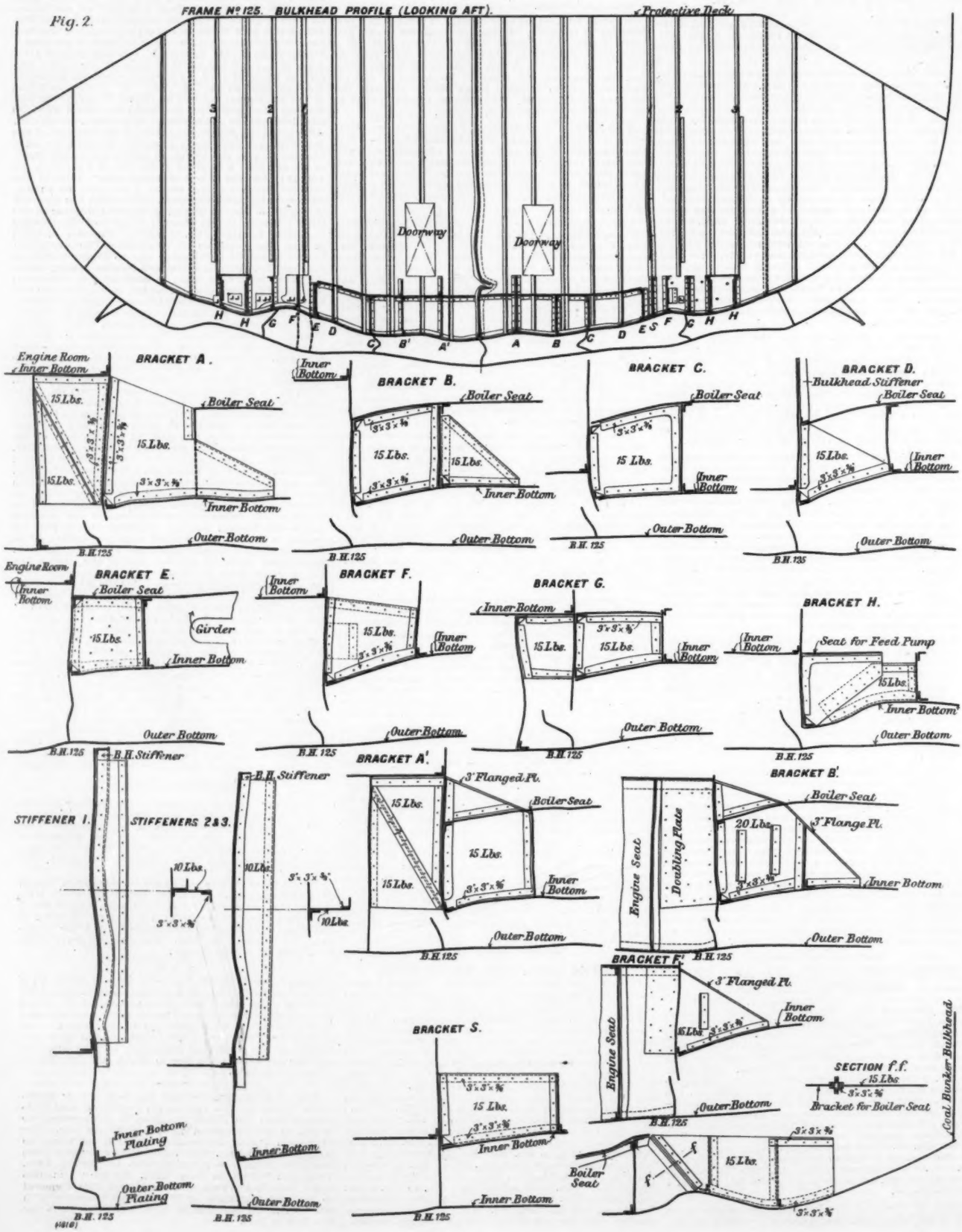
ENEMY FIRMS WOUND UP.—The issue of the *Board of Trade Journal* for August 3 contains a consolidated list of enemy firms which have been ordered by the Board of Trade to be wound up. The list comprises the names of 279 firms and is complete up to the Orders issued on July 31. The date of the Order, and the name and address of the Controller appointed, in each instance, are also included in the list, to which an alphabetical index is appended.

ROAD LOCOMOTIVES.—There has been a very appreciable falling off this year in the exports of road locomotives from the United Kingdom, in consequence, no doubt, of the depression occasioned by the war. The expression "road locomotives" should be taken to include steam rollers. The value of the exports in June was only 13,995*l.*, as compared with 126,908*l.* in June, 1915, and 76,714*l.* in June, 1914. In the six months ended June 30 this year road locomotives were exported to the aggregate value of 209,073*l.*, as compared with 827,096*l.* in the first half of 1915, and 337,711*l.* in the first half of 1914.

THE SALVAGE OF THE JAPANESE ARMOURED CRUISER "ASAMA."

(For Description, see Page 102.)

Fig. 2.



RAILWAY PONTOON BRIDGE ACROSS THE MISSISSIPPI RIVER; THE CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY.

(For Description, see Page 115.)

Fig.24. GENERAL ARRANGEMENT OF OPERATING MACHINERY.

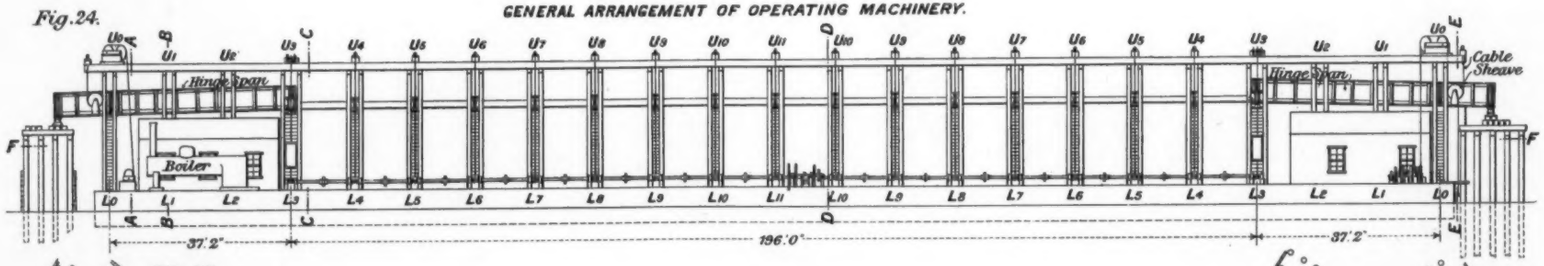


Fig.25. SECTION F.F.

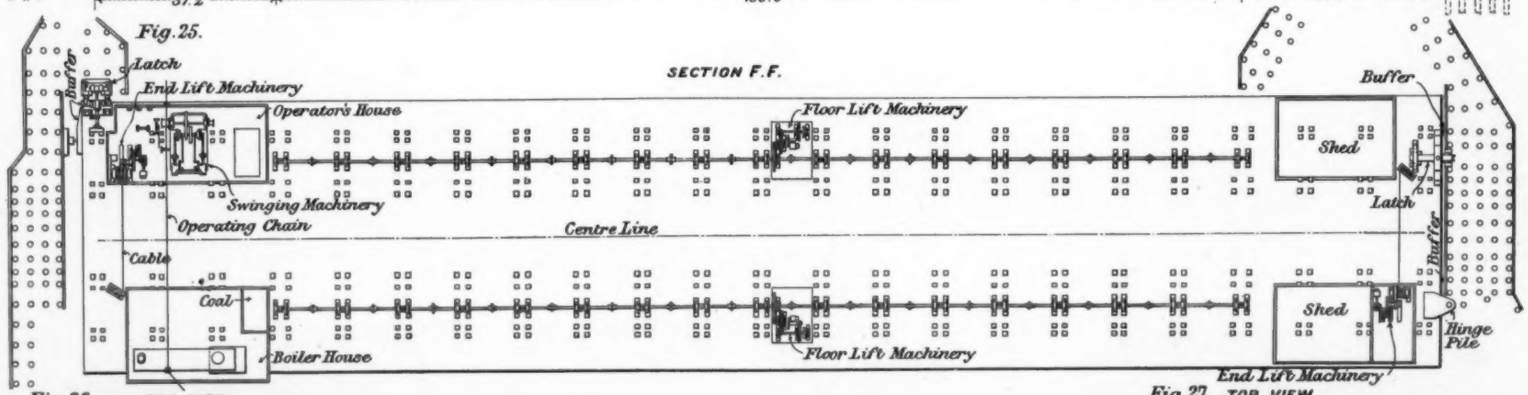


Fig.26. TOP VIEW

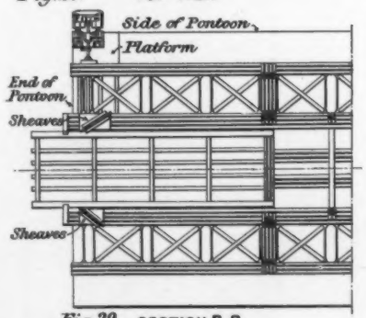


Fig.28. SECTION A.A. SHOWING LATCHES & TOWER AT LOCK END.

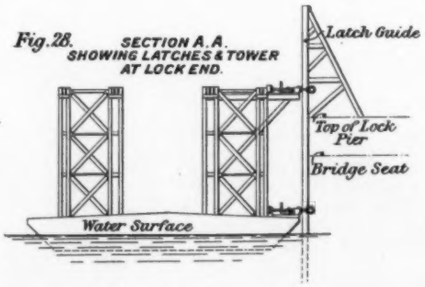


Fig.27. TOP VIEW

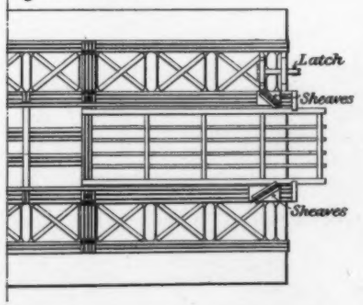


Fig.29. SECTION B.B.

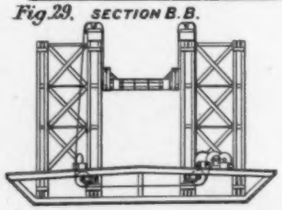


Fig.30. SECTION C.C.

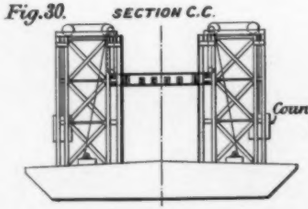


Fig.31. SECTION D.D.

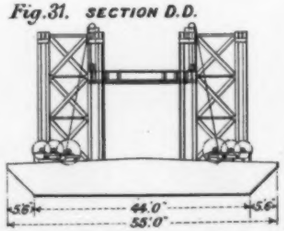
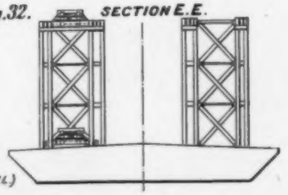


Fig.32. SECTION E.E.



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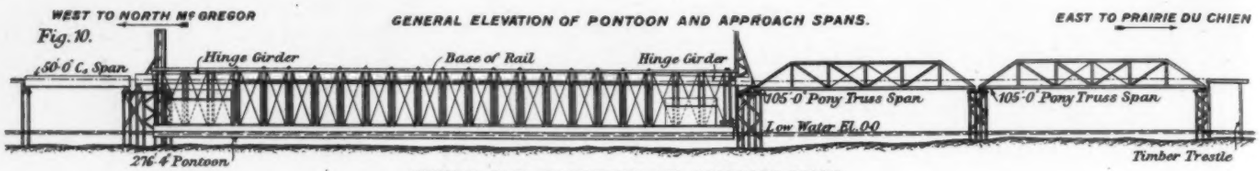
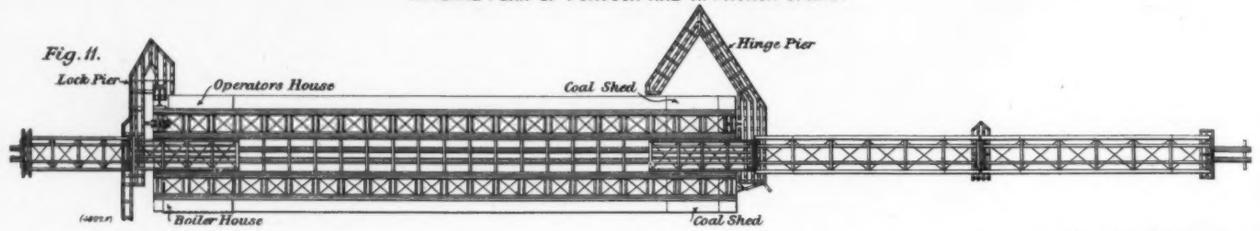
RAILWAY PONTOON BRIDGE ACROSS THE MISSISSIPPI RIVER;

(For Description see Page



GENERAL PLAN OF PONTOON AND APPROACH SPANS.



GENERAL LAYOUT SHOWING OPERATING CHAIN

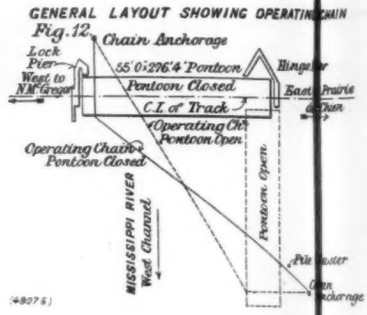


Fig. 15. CROSS SECTION AT PANEL POINTS L3.

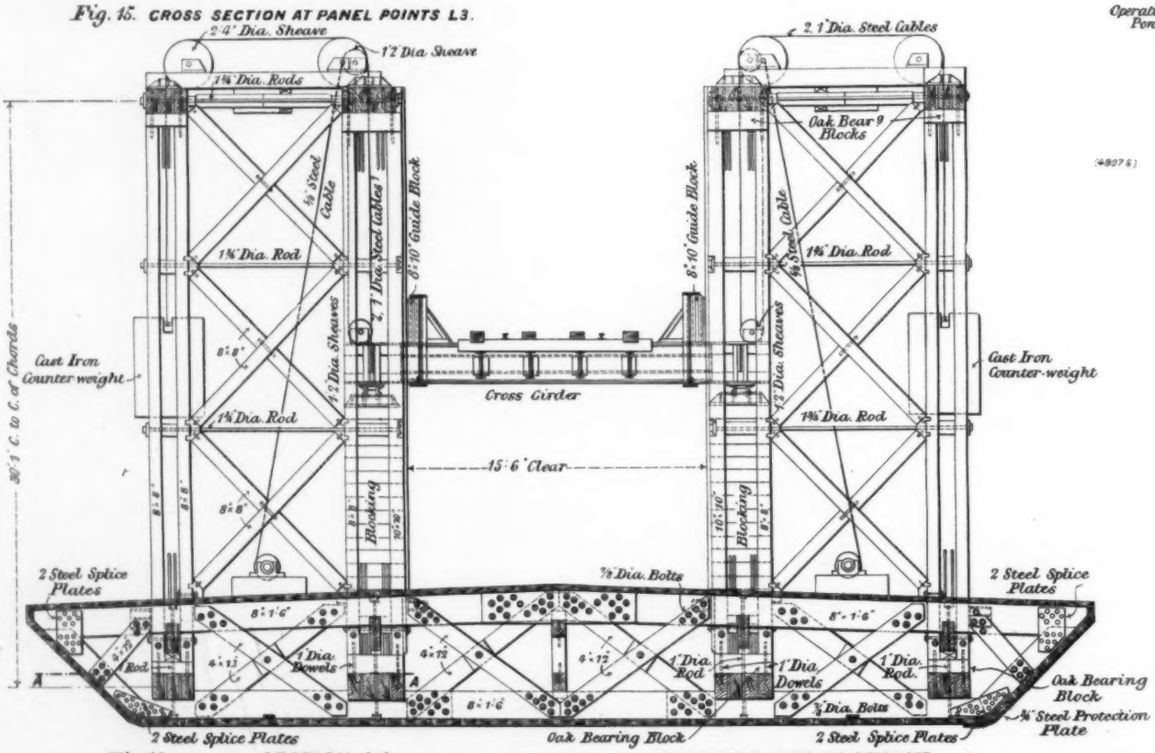


Fig. 16. SECTION A.A.

TOP VIEW SHEATHING REMOVED.

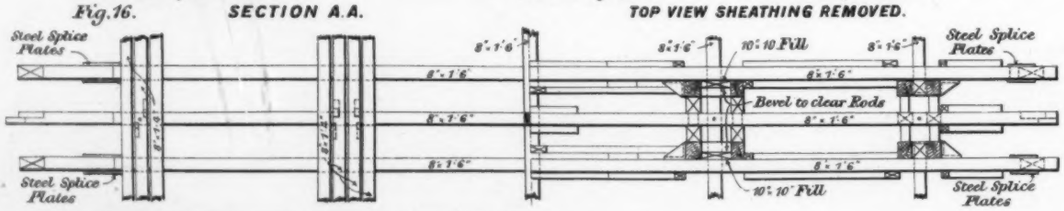


Fig. 17. LONGITUDINAL SECTION AT CENTRE LINE OF PONTOON.

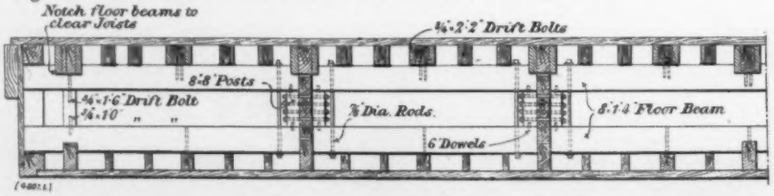
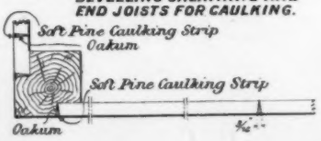
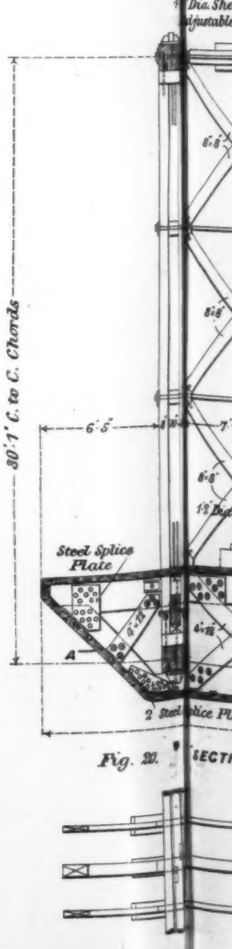


Fig. 18. SKETCH SHOWING METHOD OF BEVELLING SHEATHING AND END JOISTS FOR CAULKING.





RIVER; THE CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY.

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Fig. 13. LONGITUDINAL SECTION SHOWING PART ELEVATION OF INSIDE TRUSS

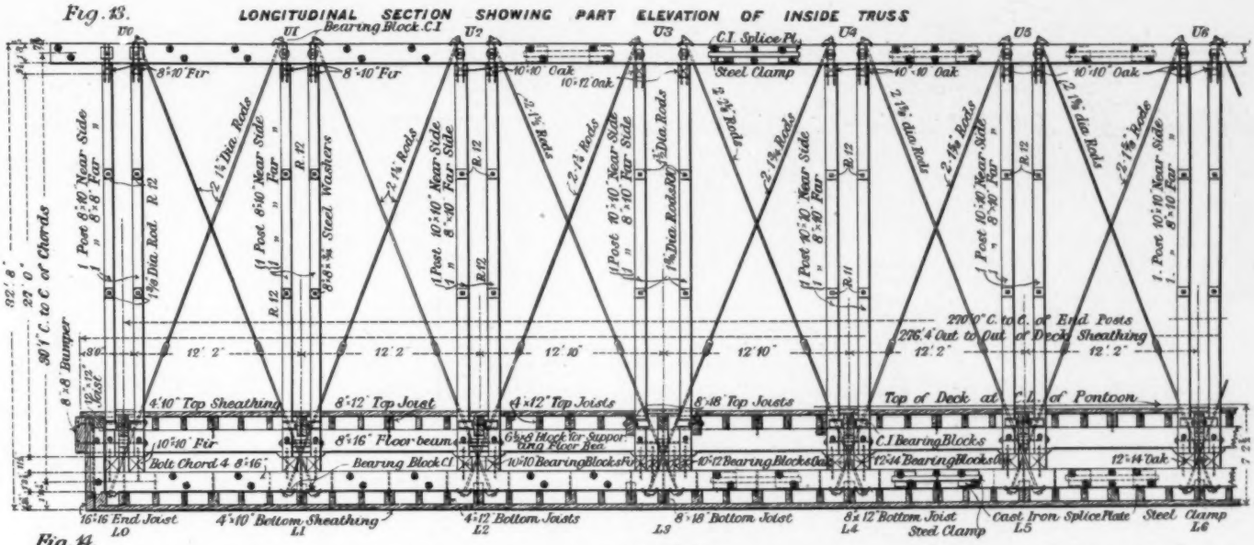

Fig. 14.

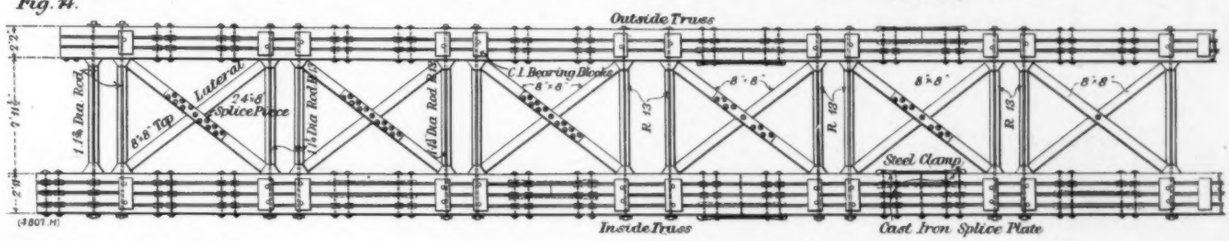

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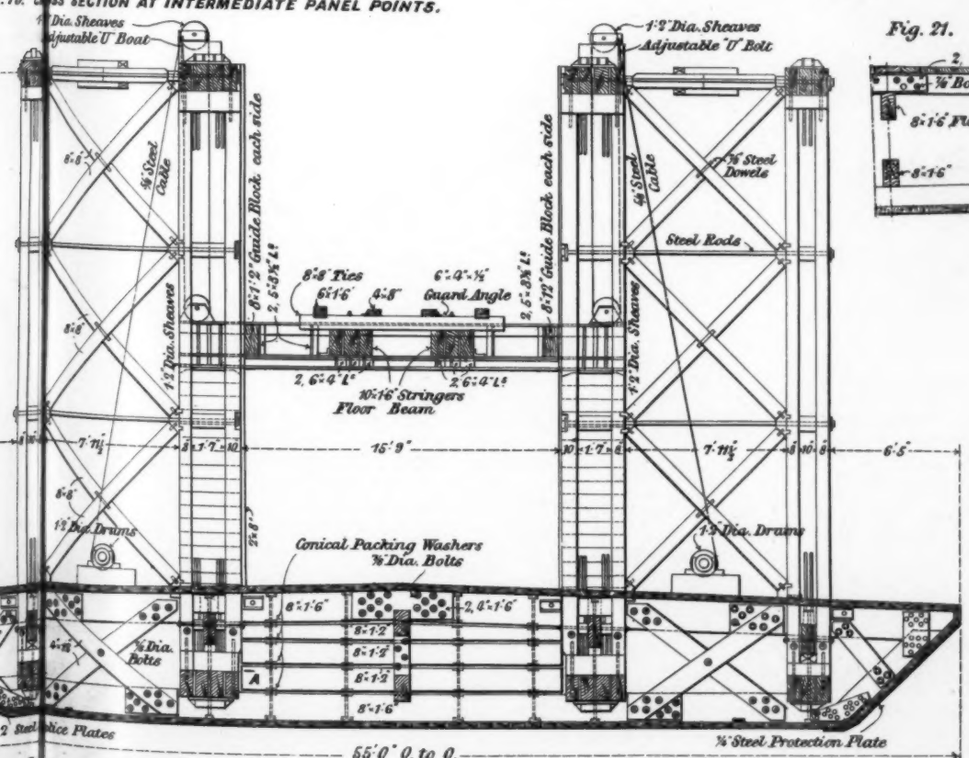
Fig. 12. CROSS SECTION AT INTERMEDIATE PANEL POINTS.



SECTION A.A.

TOP VIEW SHEATHING REMOVED.

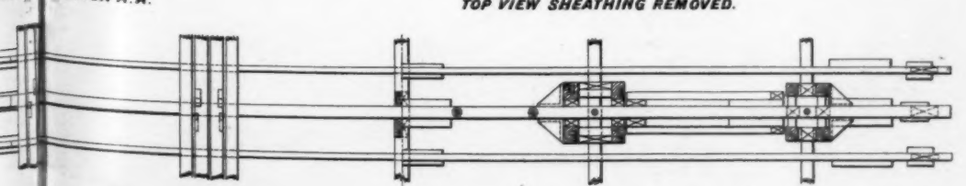
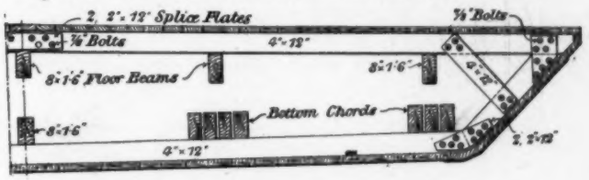


Fig. 21. TYPICAL CROSS SECTION BETWEEN PANEL POINTS.



SKETCH SHOWING ARRANGEMENT FOR TRANSFERRING THE LIVE LOAD TO THE TRUSSES.

Fig. 22.

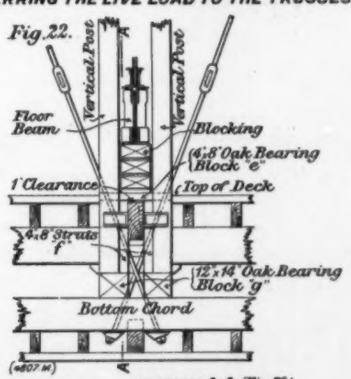


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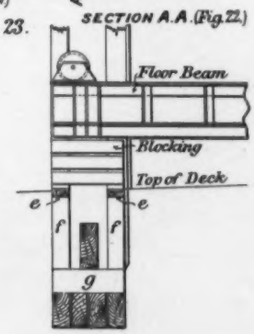
Fig. 23. SECTION A.A. (Fig. 22.)



RAILWAY PONTOON BRIDGE ACROSS THE MISSISSIPPI RIVER; THE CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY.

(For Description, see Page 115.)

Fig. 33. VARIATION OF WATER LEVEL 1912

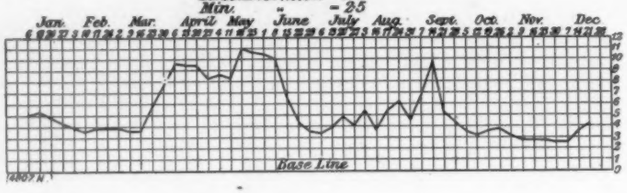


Fig. 34. DETAILS OF FLOOR LIFT MACHINERY

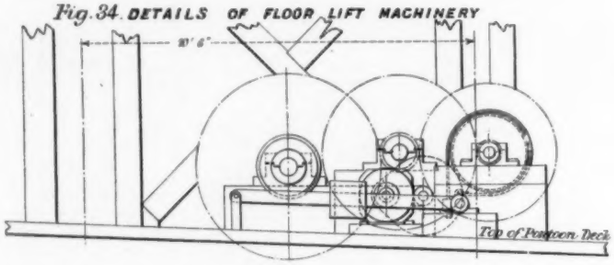
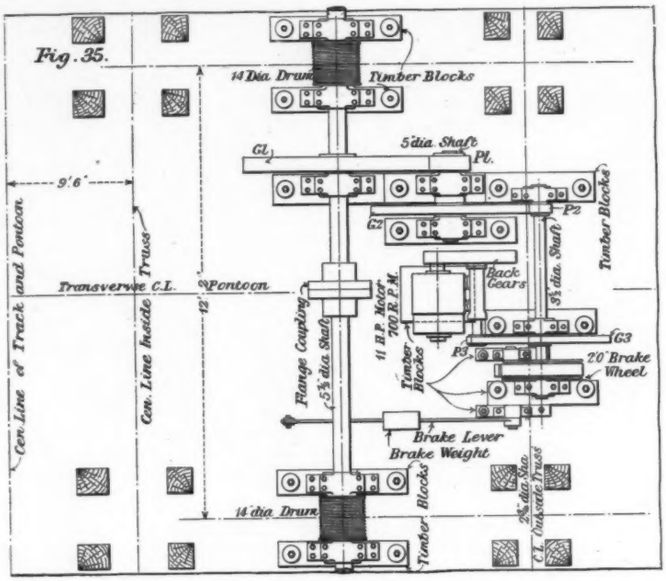


Fig. 35.



DETAILS OF FLOOR LIFT CABLES AND SHEAVES.

Fig. 36.

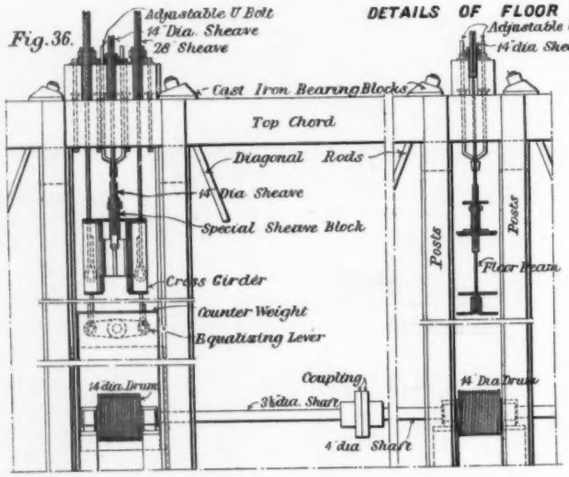


Fig. 37.

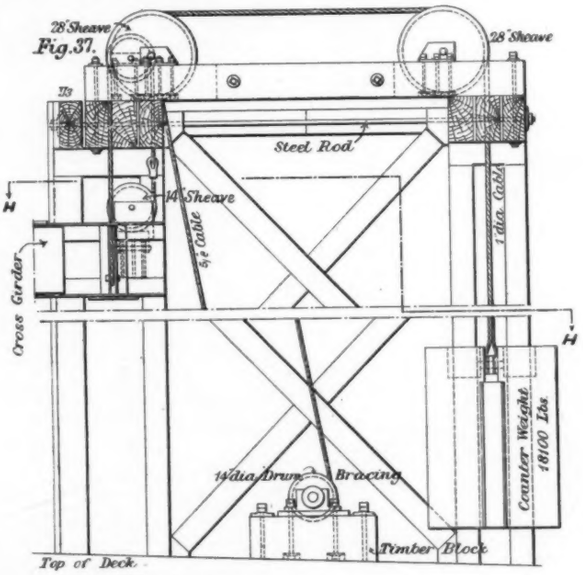


Fig. 38.

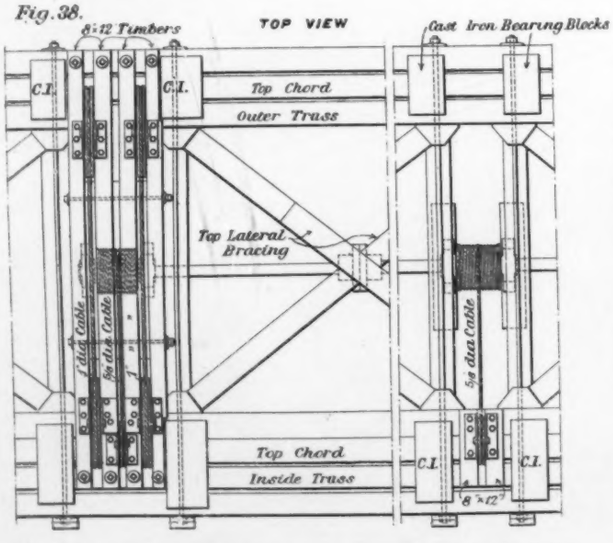


Fig. 39. SECTION SHOWING TOP ONLY.

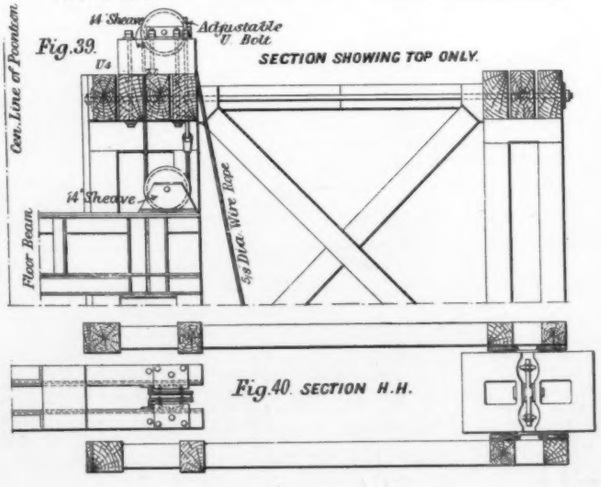


Fig. 40. SECTION H.H.

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TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3668 and 8596 GERRARD.

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With One Two-Page Plate and Two One-Page Plates of the RAILWAY PONTOON BRIDGE ACROSS THE MISSISSIPPI RIVER; THE CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY.

NOTICE OF MEETING.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, August 5, in the Wood Memorial Hall, Newcastle-upon-Tyne, at two o'clock. The following papers will be open for discussion:—"Modern American Coal-Mining Methods, with some Comparisons," by Mr. Samuel Dean. "The Hirsch Portable Electric Lamp," by Mr. Hiram H. Hirsch. "The Logic of Trams," by Mr. John Gibson. "The Influence of Incombustible Substances on Coal-Dust Explosions," by Mr. A. S. Blatchford, M.Sc. The following paper will be read or taken as read:—"Notes on the Seventh Report of the Explosions in Mines Committee," by Mr. James Ashworth.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, AUGUST 4, 1916.

THE ROYAL AIRCRAFT FACTORY.

IN our last issue we published an abstract of the "Report of the Committee on the Royal Aircraft Factory, and Report to the War Committee by the Air Board on the Subject of the Royal Aircraft Factory." Our readers may be pardoned if they feel some confusion as to the identity and purposes of the various committees which have been appointed in connection with our air services. Early in March there was in existence a Special Air Services Co-ordination Committee, of which Lord Derby was Chairman. On March 14, Dr. Macnamara, Secretary to the Admiralty, announced in the House of Commons the constitution of the Joint War Air Committee, again with Lord Derby as Chairman. The terms of reference for the Committee on the Royal Aircraft Factory were issued on March 30, and extended on April 18. On May 8, Mr. Tennant, in the House of Commons, announced the names of the Committee "to inquire into the administration and command of the Royal Flying Corps." On May 18, Mr. Tennant, in the course of a speech, explained that it had been arranged that an Air Board should be constituted under the presidency of Lord Curzon. We are not quite certain that this exhausts the list, but it goes far enough to show that our air services have been and are the subjects of many inquiries. The Committee which attracts the major proportion of public attention is that to inquire into the administration and command of the Royal Flying Corps, and before which Mr. Pemberton Billing gave evidence on many occasions lately. This, however, has nothing to do with the Committee whose report we are considering, and which consisted of Sir Richard Burbidge, Sir Charles A. Parsons and the late Sir H. Frederick Donaldson.

The reference to this Committee was "To inquire and report whether, within the resources placed by the War Office at the disposal of the Royal Aircraft Factory and the limits imposed by War Office orders, the organisation and management of the factory are efficient, and to give the Army Council the benefit of their suggestions on any points of the interior administration of the factory which seem to them capable of improvement." The constitution of the Committee was most satisfactory. Sir Richard Burbidge is known to be a most successful business man, who has organised one of the largest retail concerns in London and brought it to a fine pitch of prosperity. Sir Charles Parsons is too well known to our readers both as a scientific and manufacturing engineer to need any introduction; while Sir Frederick Donaldson not only brought to the Committee a long experience in the manufacture of the munitions of war at Woolwich, but also—and what was perhaps still more valuable—a complete knowledge of War Office methods. The Committee was appointed on account of the loudly expressed complaints of the aeroplane manufacturers concerning the Royal Aircraft Factory, and also on account of the dissatisfaction of the Services with machines for which it was held, rightly or wrongly, to be responsible. Added to this was the annoyance of the public at our non-success in dealing with Zeppelin raids, a feeling which struck at any official body connected with the air service, whether it was in any way responsible or not.

The evidence which was laid before the Committee has not been published, but we may feel sure that it was properly considered, and that the conclusions are founded upon it. The exigencies of the time have required some very serious omissions in the report, viz., the number of machines constructed respectively by the factory and by private contractors, the value of the orders placed with the factory, the number of officials and workpeople, the salaries and the wages. The places where these figures should appear in the report are occupied by asterisks. That the money expended and the men employed run to large figures is fairly certain. Only last Tuesday, Lord Montagu stated, in the House of Lords, that the expenditure at the factory this year would be about a million sterling, and that the number of men employed in the stores department was 560. It is clear, therefore, that unless the management is good there is ample opportunity for leakage and waste. Charges of this kind were made before the Committee which has been inquiring into the administration and command of the Royal Flying Corps, and were repeated by Lord Montagu last Tuesday, but there seemed to be a good deal of animus in them and they lacked definiteness. If they could be proved they would constitute a very serious reproach to the management of the factory, for the Report states, "The whole administrative system appears to us to be extremely elaborate, both as regards the records of all particulars of the material used in the manufacture of each part of an aeroplane or engine, and also as regards the course through which the components pass in the various stages from the raw material to the finished article." Again, "It has appeared to us that the numbers now engaged in the central office, stores, and other departments of a non-productive nature, reveal an organisation more liberal than is generally found in Government establishments, and on a scale unknown to us in private works." Evidently the whole place is swathed in red tape, and yet the authorities have brought a man before the court for carrying away parts for use in an aeroplane he was building at home. Lord Montagu related that the man jocularly remarked that if he had been strong enough he could have taken away a whole airship. The only justification of red tape is success, and if an organisation "on a scale unknown in a private works" cannot prevent material being carried out of the place, it is not only a failure, but an expensive failure.

The justification of the existence of a Royal Aircraft Factory is that it shall undertake experimental work beyond the capacity of a private firm. A great deal of such work has been done at Farnborough, but in addition ordinary manufacturing work has been carried out. The proportion of this, according to a table checked by Colonel M. O'Gorman, is 35 per cent. of the total; but this figure is contradicted by Earl Curzon in a supplementary report, in which it is stated that the figure of 35 per cent. accepted by Colonel O'Gorman represented new experimental construction, &c., and not construction of aeroplanes. This is contained in a second Report to the War Committee by the Air Board on the subject of the Royal Aircraft Factory, signed by Earl Curzon and bound up with the first report. As far as our memory serves, it is an entirely novel proceeding to subject a committee's report to another committee for criticism, and to issue the two opinions together. Lord Curzon puts the proportion of work involved in the actual construction of aircraft at 10 per cent., and then he goes on to contradict a good many of the recommendations of the first Committee. Whatever may be the exact figure, it is certain that the Aircraft Factory might be better employed, and that it has not been particularly successful in the way it has done its experimental work. We admit, at once, that the matter is one of immense difficulty. The scope of the air services is expanding day by day, and they have to meet German machines which are constantly growing in speed, range and gun-power. Under such circumstances there must be constant changes of design, and even after orders have been given out, alterations in dimensions of parts may

be called for, involving the scrapping of parts already made and the substitution of others. But such considerations will not account for "absolute errors in drawings," particularly in view of the very elaborate organisation for checking and control. Such a factory needs a very strong head to discriminate between the claims of perfection and of the practical needs of the moment. One knows that if an enthusiastic designer be given too much of his own way he will involve a manufacturing concern in endless delay by introducing alterations week after week. As it is, the Committee were informed that the preparation of a complete design of a new aeroplane occupies from six to nine months before any practical building in quantities can commence, and that during this period full-size experimental machines are being produced in the shops concurrently with the working drawings. Nine months form a fairly large proportion of the period of even a long war, and it is to be hoped that the manufacture of older type machines is not intermitted during the experiments. It is clear that the factory has great difficulties to face, and that, whatever it does, it cannot avoid giving rise to irritation among manufacturers. But it is also clear, reading between the lines of the Report, that it has gone outside its proper functions, and that in the work which rightly belongs to it it has not been particularly successful, otherwise the Committee would scarcely have recommended that it should "be reorganised and managed as nearly as possible upon a commercial and engineering basis." With regard to the speed of our aeroplanes, the Committee state that "there would appear to have been some lack of foresight (whether on the part of the Royal Aircraft Factory or of the War Office is not clear) as to the size of the engines required to meet war conditions."

It is scarcely worth while to follow the suggestions for the reorganisation in detail, as many of these are controverted by the Air Board, which is the superior body. Both Reports agree in this respect, however, in recommending that the factory shall be placed under the management of thoroughly efficient men of high technical ability, and the first Report adds that such men cannot be obtained and kept unless they are adequately remunerated. It is doubtful if a Government establishment will ever attain to the efficiency of one under private control; such a thing will certainly not occur as long as the terms offered leave all the best men outside. It is an immense task to keep up a continual supply of aeroplanes in France, Greece, Egypt, Mesopotamia and East Africa, and at the same time to make each lot more efficient in some respect—speed, climbing power, stability, or equipment—than the last, and no motives of economy should be allowed to interfere with the selection of the most capable man to undertake it. And the head of such a factory should be given a free hand with his subordinates. The vested interests which obtain in the Civil Service, and which provide security of tenure in office to all who do not flagrantly misconduct themselves, are quite out of place in an engineering establishment. There every one must be under the control of the chief if the greatest efficiency is to be attained, and he, again, must not have his time occupied in attending to the demands of War Office clerks who imagine that the compilation of elaborate returns is the most important thing in life.

It is pleasant to turn from the records of divided counsels, from committees piled upon committees, and from reports contradicting reports, to the doings of our airmen at the front. Whatever may be the defects of their machines, they continue to keep the supremacy of the air. There are losses and mishaps, of course; these occur in all wars. But it is impossible to believe that the Germans can be much better equipped than ourselves when they so seldom venture over our lines, while we sail over theirs day after day. The credit belongs in the first place to our men, but their courage would scarcely avail unless they had satisfactory machines. These have been improved immensely during recent months, due to researches carried out by the National Physical Laboratory, the Aircraft Factory, and the private manufacturers. The report speaks as if the functions of the latter were only to carry out the designs got out at the factory, whereas it is well known that some of them, at least, are continually carrying out important researches and introducing valuable improvements. Nothing could be more disastrous than that the designing of aircraft should fall into one set of hands, however capable they may be. It is only by continual competition between rival firms that steady progress can be made, and while there is a great field which can be efficiently occupied by the Royal Aircraft Factory, the best results can only be attained by the aggregate effort of all concerned in the manufacture. We look to see the factory fully occupied in experimental work, but acting in friendly rivalry with the private firms.

STATE FINANCIAL SUPPORT FOR INDUSTRY.

The announcement in the House of Commons on Monday by the Chancellor of the Exchequer of the formation of a banking corporation, to be assisted by State subsidy, with a view of developing trade, is one of the most welcome statements made in connection with the great campaign for the expansion of industry now and after the war. It is true that the corporation is to concern itself with trade relations with Italy only, but it may be accepted as the beginning of a far-reaching policy with immense potential advantages. There is already the promise of a corresponding institution in connection with commercial relations with Russia. The policy is one which we advocated a few months after the outbreak of war.* The normal banking system in this country has much to commend it, with all its limitations. It is essentially characteristic of that solid safety which is traditional to the British people. No money is advanced except on sound security, and it must be confessed that a direct consequence was the ease with which we overcame the financial crisis due to the outbreak of the war. In our article on December 4, 1914, on "The Influence of Banks on Industry," we stated that the desirable scheme was to establish "an industrial bank under the Joint Stock Acts, with a large proportion of the capital subscribed by the traders of the country, and then for the Government to subscribe for the remainder of the capital and guarantee a moderate interest on the share capital for a term of years." This is what has been arranged by the Government after the lapse of 18 months.

A British company, under the title of the "British-Italian Corporation, Limited," has been formed, with a capital of 1,000,000 sterling, all of which has been subscribed privately, chiefly by banks. The British Government agree to contribute to the company, by way of subsidy, during each of the first ten years after its incorporation, the annual sum of 50,000*l.*, or the equivalent of 5 per cent. on its paid-up capital if less than 1,000,000 sterling. The company, on its part, agrees to pay to the Government amounts equal to any dividend, above accumulated dividend of 5 per cent. per annum, which the directors may distribute to the shareholders in any year. The directors, however, have the right before paying dividends to make such provision as they think desirable for bad and doubtful debts and for the establishment of a reserve fund. The repayment of contributions to the Government is to terminate when the Government have received the amount paid by way of subsidy to the company, but without interest, during the first 10 years of its incorporation. The Parliamentary authorisation of the scheme is a very simple matter, as clauses will be introduced in the next Government War Obligations Bill sanctioning the payment of the subsidies. The counterpart of this British corporation is to be a company in Italy, formed under the Italian law, with a capital of 400,000*l.*, one half of which is to be taken up by the British-Italian Corporation, Limited, and the other half by the Credito Italiano and their friends. The British directorate is to include representatives of British banking and industry with three representatives from Italy, and, similarly, of the nine directors of the Italian company three will be British. The two companies are to work together and their interests will be closely identified; but the subsidy of the British Government is exclusively for the British company.

The project broadly outlined by Mr. McKenna will meet a great necessity. There is no reason whatever why similar institutions with counterparts in other allied and neutral countries should not at once be organised. As to their influence on industry there are immense possibilities, provided such industrial banks will modify greatly the excessively safe procedure of our joint stock banks, and will be prepared to take what is regarded on the Stock Exchange as "safe risks," where the remuneration or rate of interest is adequate. When we first advocated the scheme 18 months ago, we supported the view that such industrial banks should secure the advantage of the experience gained by existing banks and that their machinery should be invaluable, but that there should be a greater tendency to finance large contracts than to lend money on Stock Exchange transactions. We pointed out then that bankers' loans to the Stock Exchange often reached the enormous total of 80,000,000 sterling, while on the other hand, unless the greatest possible security were provided, traders had little or no support. If the aim of the new corporation is to be achieved, the method of making advances must be broad. Assistance should be given to traders on the security of their own businesses, by which is meant the whole of the assets of the business, including book-debts, goodwill and plant. The discounting of long-dated bills of exchange should also be undertaken, more especially as they constitute a very good security, since bills are based upon actual value, supported by accredited endorsements. Advances should also be made against orders in hand. The directorate no doubt will secure in an advisory capacity the services of experienced business men to determine the soundness of proposals by clients for establishing businesses or business connections.

It is important that the resources thus established, with Government subsidy, should be exclusively utilised for trade between the two countries embraced in each scheme; in the first instance between Britain and Italy; in others, between Britain and Russia, &c. Thus there will be no possibility of the financial resources being utilised for buying bills which represent, say, a cargo of electrical machinery *en route* from Berlin to Buenos Aires or a shipload of nitrates from Chile to Hamburg. In the past there has been too much of such assistance to other countries than Britain. It is true that as the bills were well backed and represented goods in transit, with underwriters behind them, they were safe and afforded lucrative employment to British money and brought some gain; but the maximum profit was not realised, since equal gain to the banking institutions could be derived from the employment of our financial resources in the interests of our own industries. That should be the policy of the future; that is what the British-Italian Corporation, with its counterpart in Italy, has been established to secure. We hope that the principle thus satisfactorily accepted will be applied to other countries, and at once, in order that the whole of the machinery may be set up and in working order, to enable a large and immediate flow of trade between the Allied nations and friendly neutrals immediately the fighting ends.

THE FLOW OF VISCOUS LIQUIDS THROUGH PIPES.

Less than a year ago* we noticed the experimental research on "The Viscosity of Oil in Relation to its Rate of Flow through Pipes," which was conducted by Dr. Glazebrook and Messrs. Higgins and Pannell at the National Physical Laboratory. Two series of similar experiments, we see now from a communication by Professor W. K. Lewis to the Journal of Industrial and Engineering Chemistry of July, 1916, were carried on about the same time in the Massachusetts Institute of Technology at Boston by Messrs. Greenough and Dinsmore, and by Messrs. Haylett and Lucy. In the first series two horizontal lines were built, one of 1 in. pipe, 136 ft. long, and the other of ½ in. pipe, 63.8 ft. long. In the second series the oil was pumped from a tank of 400 gallons capacity into an iron drum and then through four lines, one of 2 in., one of 1 in., and two of ½ in. pipes. Three of the pipes were of wrought iron, the fourth (¼ in.) pipe

* See Engineering, vol. xcviii., pages 333, 419, 615.

* See Engineering, vol. c., page 522, Nov. 19, 1915.

was of steel; a certain (not specified) length of the pipes was straight, and the oil was returned to the starting point and delivered into tanks on platform scales. In the second series, in particular, the rates of flow were observed at considerable velocities ranging up to 20 ft. per second. Under these conditions the flow may be turbulent, and the practical point of the research is that a simple method is deduced by means of which it can easily be calculated what rate of flow may be expected in a pipe line of given dimensions under a certain head.

Poiseuille's formula, it is well known, holds for stream-line or parallel flow (called also viscous flow by Professor Lewis) through capillary tubes, up to 5 mm. in diameter, as long as the velocity remains below the critical velocity at which the flow becomes turbulent (or sinuous). Poiseuille's formula is $p = 8\eta l v/g r^2$, where p is the pressure drop in lb. per sq. ft., η the coefficient of viscosity (in lb. per second per sq. ft.), l the length and r the radius of the pipe (in ft.), v (or V_m) the mean velocity of the fluid in ft. per second. For velocities above the critical speed, various formulæ have been proposed on the strength of experiments with water, steam and air; they are all of the form $p = f s l v^2/g r$; ρ is the density of the liquid, and f the hydraulic coefficient, and this formula is adopted by Professor Lewis. The p is a function of l, v and r, and the function is influenced by the f, which depends upon the viscosity. Viscosity measurements were made by the Gurney viscosimeter, which is a vertical tube (jacketed with steam or water) through which the liquid is drawn by a pump; the formula of Gurney was not adopted, however. The value found for f was: $f = f_w\ (0.955 + 0.045\ z)$ where f_w is the hydraulic coefficient for the flow of water through a pipe of the respective dimensions (to be looked up in tables) and z the relative viscosity of the liquid, *i.e.*, the viscosity referred to water. The z is measured in the usual way, by determining the relative times of efflux of the liquid and of water through the same Gurney capillary. This formula for f shows that for liquids of low viscosity, the carrying capacity of a pipe will practically be the same as that for water; for, when z is approximately 1, f becomes equal to f_w. With higher viscosities the carrying capacity rapidly decreases, and the formula, Professor Lewis points out, would not hold for liquids (like glycerin and heavy oils) whose viscosities are more than 20 times as great as that of water. The relative viscosity z multiplied by 0.0671 (which is the viscosity of water at 20 deg. C.) gives the absolute viscosity η in pounds per second per sq. ft.

The practical outcome of the research is the following. We have two formulæ for p, one for stream-line flow, one for turbulent flow; we thus find two values for the velocity v. The smaller of these two values, v_1 or v_2, will give the answer to the problem. An example will make this clear. Supposing we wish to find the velocity of an oil of density $\rho = 0.91$ flowing through the length l = 600 ft. of standard pipe (1.07 in. internal diameter = $2r$) under a head of 30 ft. = h; at 20 deg. C. the oil gave a time of effiux of 108 seconds, water giving 4.90 seconds; then: $p = h\rho = 30 \times 0.91 \times 62.3 = 1701$ lb. per sq. ft.; $2 = 108/49 = 22.05$; $\eta = 0.0671$; $z = 1.478$; $r = 1.07/12 \times 2 = 0.0446$; f_w (from hydraulic tables) 0.0075; v_1 (for stream-line flow) $= p g r^2/8\eta$; $l = 0.0153$ ft. per second; v_2 (for turbulent flow) $= \sqrt{p g r / p l \rho} = 2.22$ ft. per second. Thus the stream-line flow requires only a fraction of the pressure needed for turbulent flow, and $v_1 = 0.0153$ ft. will be the answer. Experimentally, the formulæ have been substantiated only for pipes up to 2 in. in diameter and for relative viscosities of 20. They may roughly be applicable for larger pipes and more viscous liquids. If a pipe is carrying liquid in viscous motion, increase in size is always well worth consideration; for with viscous motion doubling the pipe radius increases the velocity 4-fold and the discharge 16-fold for the same drop of pressure.

Personal.—Messrs. Wonham, Sanger and Bates, Inc., of 17, Battery-place, New York, and 3, London Wall-buildings, London, have changed their name to Wonham, Bates and Goode, Inc.

NOTES.

Emission Spectra in Chemical Industry.

To urge the importance of spectroscopical analysis for industrial purposes may appear altogether superfluous. A paper on "Emission Spectra in Chemical Industry," read by Dr. Judd Lewis, F.I.C., before the Birmingham Section of the Society of Chemical Industry in March last, however, illustrates the advisability of studying emission spectra even in industries like brewing. Emission spectra are produced by incandescent bodies; flame, arc and spark spectra all belong to this category, and it might be thought that their study could hardly interest the fermentation chemist, since he is concerned with organic compounds, which incandescence would, of course, destroy. But the brewer, like the engineer, manufacturer and farmer, largely depends upon the water supplied, and in water analysis spectroscopy renders excellent service. The early spectroscopic work of Bunsen, in fact, became popular by his analyses of well-known medicinal springs, the virtues of which were thus traced down, rightly or wrongly, to certain elements. The spectroscopic analysis of the air, it would appear from Dr. Lewis's inquiries, is equally important for brewers. Messrs. Murphy and Lonsdale had informed him that they had found the air of manufacturing districts generally purer biologically than country air, not so much apparently on account of the sulphurous and nitrous fumes as owing to the presence of certain heavy non-metallic and even rare constituents which smelting works discharge into the air. They did not say which elements they meant; arsenic, phosphorus, selenium, tellurium, &c., were possibly thought of. That these elements should injure the enzymes active in fermentation would hardly have been expected; but abnormal phenomena observed in brewery practice distinctly point to that conclusion. That the spectroscope will render good service to the metallurgist needs no emphasis; we doubt that it is as much utilised in common practice as it might be. Traces of foreign metals, which a rapid analysis might not disclose, become at once revealed by the spectroscope, and from the relative intensity of the lines it is in many cases quite possible to draw conclusions as to quantitative relations. The spectroscopic method is particularly suited for comparative tests. Glasses can very conveniently be analysed in this way, and the spectroscope shows traces of metals in the ashes of barks and roots as well as in other ashes. It is easy to ascertain by means of the spectroscope whether a silk was weighted chiefly with aluminium, or with tin, silicon, magnesium, &c. Very small quantities of the materials suffice for the examination; a hundredth of a milligramme of a metal, and even much smaller quantities, can easily be detected in most cases. Really quantitative estimates cannot be made by the aid of the spectroscope, it is true. Yet Dr. Lewis was able to demonstrate that the nickel percentage in a soap—due to a contamination of the fat with nickel—could be estimated within 0.00001 or 0.00002 per cent. by the spectrograph, just as well as by chemical methods. Good instruments are, however, required. Since many characteristic lines occur in the ultra-violet, quartz lenses should be used, and Dr. Lewis made his demonstrations with the aid of a quartz spectrograph constructed by Messrs. Adam Hilger.

Microstructure of Annealed Bronze.

Heat treatment affects the structure of a cast bronze very materially, and it is a disputed point whether, and to what extent, these changes depend upon the previous cold work which the annealed bronze had undergone. A contribution to this problem is made by Mr. Henry S. Rawdon, of the Washington Bureau of Standards, in Technologic Paper No. 60, on "Microstructural Changes accompanying the Annealing of Cast Bronze." In general it may be said that a cast bronze consists of relatively large crystals, the size of which will depend upon the rate of cooling during solidification and upon freedom from mechanical disturbance. Each grain has a complex structure. At 790 deg. C. the crystals have a dendritic appearance, a liquid, rich in tin, filling the crevices between the branches. This liquid reacts with the solid, forming a solid solution β of copper rich in tin; on cooling the β constituent breaks up into a eutectoid of the α and δ solutions of copper and tin. In the annealed bronze the large dendritic grains have disappeared and have turned into polyhedral grains of the solid α solution (richest in copper). Inclusions of tannic acid, &c., do not appear to affect this recrystallisation. The new experiments were made with the material of broken test bars of a bronze having the average composition: copper, 88.2 per cent.; tin, 9.5; zinc, 2.3; iron, traces; lead, not detected. Three kinds of specimens were prepared: hexagonal bars, 1 in. sq., cast in green sand; small crucible melts, each of 25 grammes, quenched at 700 deg. C. (so as to retain the β constituent), or cooled rapidly in air or slowly in the crucible; melts quenched at 1,200 deg. C. by dropping the crucible into cold water. Cold work was done upon some of the specimens by turning the specimen down on the lathe or by drilling a hole through it, or by both these methods. The 1-in. bars were turned down to ¾-in. cylinders; the specimens of the melts were turned down to diameters of ½ in. and then annealed, for periods of one, two, four and eight hours, at 400, 600, or 800 deg. C. It was impossible to make any direct measurements of the crystals during the process of annealing, since such measurements necessitate the preparation of a polished plane surface for observation, and the grinding, polishing, &c., would be a sufficient disturbance to cause re-crystallisation of the surface metal during the subsequent annealing. But it was found that the process of diffusion which erases the interior dendritic structure and renders the metal homogeneous is a slow one. According to Portevin, about three hours at 800 deg. C. are required; Rawdon confirms this, though in some cases the dendritic framework seemed to be more resistant; that was only apparent, however, and the crystals characteristic of the annealed state showed themselves long before the dendritic structure had disappeared. The rate of absorption of the eutectoid during heating depends much upon the previous cooling of the cast bronze; with a slow solidification the δ phase was dissolved much more slowly than with the bronze cast in sand. In all cases it was only after distortion that annealing caused re-crystallisation and twinning; metal severely strained internally by rapid cooling behaved like mechanically distorted alloy. The thickness of the re-crystallised layer was very uniform; prolonged annealing hardly increased that thickness beyond a limit, and the re-crystallisation seemed to start simultaneously throughout the layer. Up to 400 deg. C. only the most severely worked alloy was able to re-crystallise. These observations are in accordance with Tammann's views as to the re-crystallisation of cold-worked metals. According to these the distorted metal is in a state of unstable equilibrium, and a force (analogous to surface tension in the gliding planes of the lamellæ) causes the crystal fragments to agglomerate, and the crystals to grow until this force and the strength of the crystal (resisting change of form) are balanced; crystal size is thus predetermined by the temperature.

The North-East Coast Institution of Engineers and Shipbuilders—Research Committee.—The North-East Coast Institution of Engineers and Shipbuilders has recently appointed a Research Committee, which has already made a start with its work by acceding to the request of a well-known firm in the North to investigate and carry out exhaustive tests of apparatus having for its object the more economical production of power by marine steam engines.

The South-Western Polytechnic Institute.—The South-Western Polytechnic Institute, Manresa-road, Chelsea, London, S.W., will open on September 25 for day and evening classes. The Engineering Courses include lectures in Electrical and Mechanical Engineering, Physics, Chemistry, Mathematics, and practical instruction in the fully-equipped laboratories of the Institute. Students are prepared by recognised teachers of the University of London for the B.Sc. degree in Engineering of the University, for admission to the various engineering societies and the examinations of the City and Guilds of London Institute. The evening courses include, besides the engineering courses above, also classes in Electrical Wiring, and other trade subjects. Arrangements have been made for placing students who have passed satisfactorily through the three years' day course in positions with large engineering firms, and hitherto such firms have offered more vacancies than the Institute has been able to fill with its students. The prospectus may be obtained on application to the Secretary (Room 24).

TRADE WAR AND PRODUCTIVE POWER.

By H. F. L. Orcutt.

The present European crisis has roused the British manufacturer. He is evidently wide awake as to the necessity for action in respect to Allied contracts, trade combinations, Government assistance, banking and finance, and trades unionism. Although there is a great deal of talk about "trade war," there is but little evidence to indicate that our statesmen, politicians, lawyers and commercial men are very familiar with the manufacturing methods which are so largely responsible for the commercial supremacy in certain directions of the United States and Germany.

Legislation will be passed, Allied conferences will be held, and trade combinations consummated. There is little doubt that all this will be done by the intelligent and enterprising few. The chief danger is that the plodding drudgery which can only be done by the many, that which takes the longest to accomplish, will be left till the last, or, what is worse, receive little or no consideration. Germany and America's trade supremacy has not been built up by passing chambers-of-commerce resolutions and legislative protection, but by systematic hard, slogging work.

The task before us is one which will take years to carry out and must be perfected by those responsible for production—*i.e.*, the managers of our factories and the workers under them. The largest bodies take the longest time to move. That which takes the longest to accomplish should be started first. Yet so far the opposite prevails. Agitation is confined principally to the obvious, the easy, and that which should be quickly accomplished.

Supposing we win the war, legislate to protect our crippled industries, make satisfactory contracts with our Allies, form wise trade combinations, reorganise commercial methods, solve transportation difficulties, reform banking and finance and successfully cope with trade-union demands, and leave our methods of production much as they have been for 25 years, shall we be able to compete in the open market with the Americans and Germans? We shall not. Are the manufacturers of Great Britain in a position to "deliver the goods"? They are not. With notable exceptions, they have neither the equipment, the organisation, nor the trained staff which are necessary to produce in competition with either the States or Germany. There is nothing new in this situation. The English manufacturer has been repeatedly warned. Generally speaking, he has not heeded the warning.

In view of the present crisis it is certainly opportune to discuss his position in the industrial world, adhering to that which pertains to problems of production and their relation to new and extraordinary conditions. Before he is in a position to prosecute a successful "trade war" he must:—

1. Acknowledge, grasp and realise the meaning of certain facts.

2. Adopt and adhere to certain principles in the conduct of his business.

3. Lay out and vigorously prosecute certain lines of work.

The facts which he must face are those governing the industrial life of the three leading competitive countries of the world—U.S.A., England, and Germany. Although the noble work being done by France to-day entitles her to occupy a position of the highest honour among all nations, not much is to be gained either by criticising her vices or extolling her virtues. The two countries which England must meet as rivals in trade and industry are the United States and Germany. Great Britain must adopt the good and avoid the evil of these two countries. She must at the same time hold fast to her own virtues and strongholds and shake off the vices which are hindering her progress.

Ascendancy in trade can only be held by a nation whose commercial methods are correctly combined with wise legislative assistance and whose workshops are in the highest state of efficiency. Pushful trade methods and Government protection are futile unless articles of good quality can be produced at the lowest price. It is all very well to organise trade combinations, to press for legislative action and to ask for a business man's Parliament, but it is of no avail against either German or American thoroughly equipped, highly organised workshops, managed by highly trained staffs. Home trade may be easily protected by tariffs, but it is in the open market that we have to compete. It is in the open market that Germany and the United States are outrivalling Great Britain. How they are doing this is easily understood when the conditions ruling in those countries are analysed.

In these conditions we can read the problem of production like an open book. We can take advantage of the experience of others, hold fast to the good, avoid the evil, and make improvements. Some special features of American industrial life should be first considered, for the reason that the most important progress made in Germany is due to the slavish copying of American manufacturing devices and methods. Quite a number of English manufacturers are fully alive to these conditions, have adopted them, and are profiting by them. The majority are ignorant of their existence or treat them with apathy; not a few look upon them with contempt and ridicule.

In the United States the manufacturer is favoured by two unique circumstances. He has the largest home market in the world. He can put his wares on the market practically with no regard to his customers' fads. This makes it easy for him to follow a policy of preparing for turning out goods in large quantities and of a standard pattern—two essentials to low costs combined with good quality.

No better example can be found to illustrate than the American motor-car. Estimates for the near future are for an output of 1,000,000 per annum. An outside estimate for the total production of motor-cars in Great Britain is probably 25,000 annually. There are a few motor-car factories in England with an estimated capacity of from 50 to 60 per week, an output common in the States in one factory for one day. The American public take the car offered by the maker with standard body and fittings, rarely questioning even the colour. The customer in England demands individual details and fads until "manufacturing" in the real sense is impossible. In the States the maker leads the public; in England the public strangle the maker.

It may be mentioned in passing that there is little to emulate in American methods and means for cultivating and maintaining foreign trade. The United States is decidedly behind other great producing countries in the consideration given to her foreign customers.

As to the home market, in which large quantities of goods are absorbed, this is a difficult situation to meet. It probably can be met, however, by co-operation with the Colonies and Dependencies of Great Britain. In respect to individual demands of customers there should be no difficulty. The British public take the standard American article without murmur. What is true of motor-cars is true of a thousand and one articles of foreign make which the British public purchase when the combination of quality and price is satisfactory. The incidents of a large home market and accepting a standard article by the public serve to illustrate what *can* be done. We have only to learn the lesson and follow the example. How it is done is common knowledge. Successful imitation is not difficult. Contented indifference on the part of the public and the individual manufacturer is the most serious danger which we have to face. It is doubtful even now if there is, generally speaking, a real determination to try to lead industrially after the peace is won.

The work to be done is so colossal that it can only be dealt with in the barest outline. With but few exceptions, in every line of manufacturing in the United States the mechanical equipment is superior to that of Great Britain. This is so well known that it hardly needs to be mentioned. Its full significance is not grasped, however, even by those British manufacturers who are familiar with American plants and have had similar outfits in operation in England for years. To completely reform the equipment of British workshops is merely a matter of having the money to purchase plant. This must be done. To demonstrate its wisdom is not necessary. Much has already been done. It is the profitable *operation* of good plant that is not generally understood in England and in which America leads. The production of standard articles in large quantities naturally calls for the best mechanical outfit. The best mechanical outfit naturally demands the highest skill to work it efficiently. There are plenty of good workmen in England, but there is a lack of skilled men who understand the operation and management of automatic machinery and refined methods of production. Even in the States conditions are not satisfactory in respect to the quantity of skilled mechanics, who cannot be trained in less than from three to five years. In England there is no problem connected with our industry and trade which is of such pressing importance as the training of skilled men. Legislative actions, trade agreements, allied compacts and purchase of plant are a matter of weeks, or a few months at the outside. Training of men to operate our plants effectively is a matter of years. As has already been stated, it is high time we gave attention first to those things that take time to accomplish. This problem should not be left to cumbersome and muddling Government action. The problem is so vast, so far-reaching, and has such intricate ramifications, that it is beyond the imagination to conceive how any one can advocate depending upon governmental initiative and control for its solution.

The work of training our men must be done by those who know what is wanted and by those who alone have the means in their own shops of educating supervisors and managers. Again we can learn from the States, who realise the situation and know what it means to have a good plant and not have enough trained men to operate it efficiently. How we must begin this work and carry it out in England is clear, but much beyond the scope of this article to deal with except in outline.

The superior productive capacity of the average American manufacturing establishment as compared with the English shop is largely due to the type of man mainly responsible for output. In the States this type is cultivated by the capitalist. In England he is usually a casual growth. In America his opportunities for advance are unrestricted. In England he is a fixture in his class as much as the working man or the tradesman. It naturally follows that in the one case he is the social and technical equal of other officials, in the other he is of inferior rank, neither consulted nor considered in many matters directly relating to his responsibilities. In the one case his authority is unlimited in his department, in the other he is too often the subject of interference and restriction. Responsibility is in the one case wide, in the other narrow, high remunerations as compared with low salaries, social standing with no barriers as compared with boundaries distinctly difficult to break through. There is not much doubt as to which country offers the highest inducement to efficiency.

In the large body of workers ranking next to managers and supervisors similar instructive comparisons can be made. They include workers like foremen, tool-makers, tool-setters, fitters, general mechanics, designers and draughtsmen, cost clerks, and factory accountants—men who must be instructed and trained in actual workshop operations for from three to four years, "indispensables" to the modern plant.

Both British and American manufacturers recognise that training of men is vital to our industries. The fundamental difference is that the American is willing to pay for the training, the Englishman is not. The result is that in the States we find apprentices paid high wages, in Great Britain little or nothing (often a premium is required). The American pays for technical training directly connected with workshop practice. The Englishman is shouting for State aid and technical school assistance paid for out of the rates. In the one country the apprentice can learn his trade thoroughly, no matter how poor his parents, in the other the mass of youths "drift" into all sorts of occupations—no training whatever. A small number may struggle through to a scholarship or have parents able to support them while serving their apprentice-

ship. In the one country we find the employer offering a carefully prepared course of training and experience, mainly with a view to producing an efficient worker; in the other the employer in most cases looking upon an apprentice as a sort of sweated labour. The results are apparent to those who have had the opportunity to observe. The American net is thrown wide and gathers both quantity and quality; the British is narrow, the catch is small, the quality poor.

The results in industry are well known. American labour is the most efficient and the highest paid. That is, any article which can be produced in quantities on specially arranged machinery can usually be turned out in the States at a lower cost than in Great Britain. This would be impossible without the assistance of the highly trained worker.

One of the most important developments in the United States affecting costs and output is what is known as scientific management. It is comparatively new and not generally adopted. It is a success beyond question. Its methods are really scientific and far reaching. It is not, so far as is known, in operation in Europe, where the few who are aware of its existence look upon it with indifference. It will be condemned at sight by trade unionism. Its relation to manufacturing is the same as that of chemistry to the production of dyes. It is so broad in its influence that it deals as completely with unskilled labour as with skilled or with the supervisor and manager. Its importance lies in the fact that it deals with the greatest number of workers, the machine attendant, the untrained worker either in purely hand work or head work, or the combination of the two.

The leading principles of the experts in this science are well worth recording.

1. Changes in methods of manufacturing to be undertaken slowly, only as rapidly as they can be kept in hand, absorbed and operated by management, staff, and workers.
2. Increased output.
3. Increase in wages.
4. Lessen fatigue.
5. Selecting the task the individual is best suited to undertake.

The leaders in scientific management insist over and over again that the above is their aim. Their order of work is, first, a complete study of conditions; second, compiling, tabulating, and digesting facts; third, suggesting new methods; fourth, training staff and workers in improved methods. Scientific management already has a large literature. It is in full swing in a number of works. Its future is assured. It is only a matter of time when it must be universally adopted. Successful competition without it is difficult, in many cases impossible.

One peculiar characteristic of the American which contributes not a little to his all-round progress is worth mentioning, that is, the free interchange of opinions and information even amongst those producing the same article. They visit each other's factories, compare notes, write papers giving details of processes and methods with a freedom that certainly makes for progress. The narrow closed-door policy of the English manufacturer is usually the opposite, to his own detriment. It cannot be said that the American attitude in this matter is dictated by patriotism or public interest. It is rather the natural accompaniment of rapid changes and freedom from conservatism. The opposite condition exists, generally speaking, in England, with obvious results; contentment with old methods and out-of-date plant being the rule instead of the exception.

There is one other advantage common to American life—that is, compared with European conditions, we find practically no social barriers which prevent the free interchange of ideas and opinions between all classes of workers. The result is that suggestions for improvements and new developments have every chance of getting a trial; not only ideas, but individuals shift from one class to another to the benefit of the whole. Ambition exists in all ranks and has a chance.

In England the social position of the individual too often circumscribes his technical work. This is a loss to industry and discouraging to individual effort. The technical and scientific expert in the States is usually on the level with the commercial manager in respect to authority, salary and social standing, a benefit to industry, an encouragement to the individual.

Germany's manufacturing position which she holds to-day is the result of studying, absorbing, and copying American machines and methods. Broadly speaking, her mechanical outfit is superior to that of Great Britain, second only to the United States. During the last 25 years she has bought heavily of American machines. She has copied them slavishly, and now produces in her own machine-shops the counterpart of nearly every one which is worth having. This statement applies to all classes of machinery for light manufacturing or heavy ship and engineering work, for the production of the manufactured article and of material. In the proper equipment of her workshops alone England has a task before she can run parallel with Germany and be in a position to turn out manufactured articles to compete in price and quality.

This is not the most serious matter for England, however, as new machinery can be quickly purchased where capital can be found. That which is the most serious is that which takes time to accomplish and which time alone can accomplish—that which Germany has been steadily consummating for a quarter of a century—that is, the adoption of those principles and methods necessary to efficiency and the training of staff and men to carry out her work. Unlike America, Germany has not the large home market. She has made, however, a large foreign market, which, combined with her home consumption, gives her the first requisite of cheap production—*i.e.*, large quantities. The pushful German travelling man is too well known all over the world. He needs no further advertisement. His adaptability, his knowledge of the language and customs of his clients, the backings of his Consular service, are too much dwelt upon by the present "trade war" enthusiasts. He is but the pioneer—the Uhlan of commerce. The warfare that follows is straightforward and conventional: standardise the article, put in special plant, adopt new manufacturing methods, train men to operate on modern lines, keep up quality and make improvements through the aid of special research.

There are some interesting and instructive comparisons in the commercial and industrial work being done in Germany and America. Good and bad in both. Broadly speaking, although the mechanical equipment of the German is pretty well on a level with the American, he lags somewhat, for the reason that the American is more original, bolder and more practical. The German is a star copyist and quick to adopt new designs and methods. He is an unscrupulous cribber and many times a foolish one. The American always will lead. His methods of working are sounder. He is first of all practical. The men from whom improvements come have a training superior to the German. This training is acquired in actual working conditions. The Germans rely on, in fact, make a fetish of, "book-learning." In his mechanical and scientific work the German is spoon-fed, as in all other things. He relies principally on some Government official for guidance, control and assistance. Without doubt the pre-war admirers of German methods of training and education will not be so much in evidence in the future.

State-controlled continuation and trade schools of Germany have little in them worth imitation compared with the systems of apprenticeship and manual training arranged and maintained by many American manufacturers out of their own pockets. Even the technical and scientific institutions of Germany are not the equal of similar organisations in the States. Comparison of the individual scientist in Germany and America is distinctly in favour of the latter. The German is circumscribed, conceited, and unapproachable, priggish and a snob. The American is broader, willing to take wisdom wherever it may be found and apply it wherever it "pays." He is usually independent of Government patronage and is paid a good salary. The German is restricted by Government regulations and low wages. One merit is common to both countries—that is, the scientific expert is looked upon as indispensable to industrial progress and efficiency. In England he is too often looked upon as a necessary evil, to be made use of after trouble comes. In one respect the German "Technicker" is unapproachable by anyone—that is, in his industry. He is a tireless plodder. No field of work is too small nor too large for his energies; no task too big nor too little; his sense of duty is high.

Although the training of engineers and workmen in Germany does not make for efficiency, as in the States, the main thing for England to note is that in both rival countries this training is undertaken thoroughly and systematically. By both it is looked upon as an essential to industrial success. It is backed by labour and capital and the Government. In England it is comparatively neglected both by employers, employees and the State. Where attempted it is usually on old-fashioned lines; the cost begrudged by the employer, the practical working opposed by trade unions. England must revise her systems of training men. She must immensely extend her work in this direction or the capital expenditure on new plant cannot be fully profitable, nor will it be possible to meet her rival in output or in quality of product.

Rightly or wrongly, the backing which the banks have given to industrial enterprise in Germany has been a most important aid to her development. Practically speaking, extension of manufacturing has never languished for want of money, banks advancing for capital expenditure as well as working funds. Any number of Germany's huge industrial plants would have been in bankruptcy but for this fact. To-day they are equipped, staffed, and have working capital which puts them in a position to compete with the foreigners, not only in respect to turning out a high-class article at a low price, but enables them to give credits and extend payments, as many an English salesman knows to his sorrow. Without doubt, the extreme examples of perfection and success, in which are combined financial backing, technical and scientific knowledge, manual skill and complete plant, are to be found in Germany. No more notable examples can be given than the dye industries, optical work and magnetos. It is little consolation to say that these industries, like others, have been developed under the fostering influence of military ambition. The methods adopted concern us and should guide us to similar success.

In the extension of her foreign trade German merchants have been assisted by low inland freight rates charged on goods for export. The opposite extreme is found in Great Britain, where inland freight rates on all goods are the highest in the world. The lowest all-round rates are in the United States. If England is to compete with these two countries in the open market, her pre-war freight rates and methods of handling goods must be revised.

In England, as compared with the United States and Germany, in addition to the conservatism and apathy of the employer and capitalist, we have the opposition and obstruction of the trade unionist. Although it exists, there is comparatively little direct opposition to innovation found in either Germany or America, neither to the installation of labour-saving machinery, the increase of output, nor the increase of the number of apprentices. The introduction of improved methods of management are directly and openly opposed by the English trade unionist. Whether this is justifiable or not, competition on the part of British manufacturers in the world's market is impossible as long as it continues.

As far as the preparation for economy in production is concerned the English manufacturer at the present time has an opportunity absolutely unique. History reveals nothing that can compare with it. The imagination can conceive nothing more complete. That which is of first importance—in fact, which is fundamental—happens to be the easiest and quickest to accomplish: easy because it requires no capital outlay; quick because everybody is ready for it, both seller and buyer. The manufacturer can now say to his customers what he must take. He can reduce the variety of his goods, eliminate faddist details which do not lend them-

selves to cheap production, and standardise in so far as may be necessary to alter his goods to a design which lends itself to making with automatic machinery and avoid hand labour. He can adopt a pretty much "take it or leave it" attitude with his customer, knowing that his competitor is doing the same. The customer is ready to fall in, knowing that it is difficult to get deliveries, whatever he may want. The willingness with which the public accept innovation is highly significant to those who know the British character.

This situation should be made use of for all it is worth. Every article of manufacture should be scrutinised in detail with a view to reducing variety and redesigning on mechanical lines. If this be freely done, it is the beginning of a sequence of reforms which naturally follow.

We can take advantage of another condition forced upon us by the crisis with which we are now struggling—that is, the enormous amount of new machinery which we have been obliged to instal for the production of war material. This country has never within such a short space of time bought and put into operation such vast quantities of up-to-date machinery. Manufacturers who have for years followed hand methods of production find themselves the possessors of automatic machinery which they never would have purchased. They have taken orders for war material (many of them without realising what they were doing) which they must execute in some way or other. They have few men who understand the machinery which they are forced to operate and with which they must turn out articles which must pass inspection and be made to gauge. They are learning the lesson and getting paid for doing it.

The plant is there, the orders are placed; the incentive to success could not be intensified. The problem of successfully operating this new machinery must be faced. The most difficult task is not yet accomplished; it is hardly realised by the majority. It is, finding enough skilled men to properly start and keep in order and to find sufficient staff trained in intensive production to organise and gradually improve the output in quantity and quality.

Compared with the States and Germany, Great Britain never has had the relative quantity of trained mechanics necessary to successfully operate automatic machinery and maintain it in a high state of efficiency. The tool-makers, the tool-setters, are of good quality, but there are not enough of them. The army has depleted our workshops of skilled men essential to big output and interchangeability, and has absorbed the skilled tool and jig-maker, without whom all the machinery in the world is useless. He is the man whom it takes four to five years to train. The dearth of these men will certainly prevent us from realising all we ought to secure from the large plants that have been put down within the last twelve months.

It certainly cannot be repeated too often that both the present and the future demand that we must give more attention to training the skilled engineer than to any other detail connected with the industries of Great Britain. The contented English manufacturer is hopeless if the national necessities of the times do not arouse him to action in this matter of apprenticeship, and training of men and staff, which are necessary to assist him to produce on modern competitive lines. This work he must undertake himself. To try to substitute another talking machine for the one now at Westminster will not help him. To expect the State or municipality to do it is impracticable, and commercial co-operation is not enough. "Tied-house" methods of securing orders will not enable him to compete. As in all other things, the healthy and lasting success will come from individual effort. Decentralised voluntary effort as found in the States is to be emulated; the centralised enervating State compulsion of Germany must be avoided.

If England will wisely legislate in those affairs which properly belong to Parliamentary action and will individually take up those reforms which can only be carried out by the individual, she can lead the world industrially. Her vast possessions and unrivalled fleet make possible a trade which no other country can hope to acquire. Many of her manufacturers have already shown what can be done. The majority have only to copy.

Probably the most profound and far-reaching of the effects of the war on English industry will be the manner in which it will influence negotiations and workings between capital and labour. It is pushing home and demonstrating economic truths and principles which have been long enough ignored by both sides. It is doing this with a rapidity impossible in normal times and at a cost proportionate to its speed.

The high wages being earned by both the skilled and unskilled worker really dominate the whole situation and may at once put obsolete or antiquated machinery out of commission. High wages combined with up-to-date plant (properly worked) usually means low production costs. This fact the English manufacturer has never fully grasped, although it has been established for years in the States. The production of enormous quantities of war material, turned out on the best labour-saving machines, supervised by skilled men and operated largely by unskilled workers, with high wages prevailing in war work, is the most valuable object-lesson British manufacturers ever experienced. The sequence of shop reforms absolutely necessary must follow rapidly. The men who must be trained and educated in the new methods are particularly a class which cannot be produced in technical schools and colleges. This refers especially to practical workers, without whom automatic high-priced machines cannot be profitably installed.

There is another class of trained men necessary which practically is non-existent in Great Britain. That is, the man with practical shop experience combined with college or technical education—men who must inaugurate and maintain organisation necessary to the successful working of the modern outfit, a radically different individual to the usual English shop manager, not that he takes the place of the "works manager," but he is an essential aid to this position. His duties and qualifications are well known and clearly defined. They vary in accordance with the size and character of the organisation of which he is a part.

The successful "dilution of labour," so called, seems to be a surprise to many manufacturers, but it is only a well-known possibility with those who really understand repetition work. Its use is natural; it will quickly expand, and is a permanent necessity. The relaxation of trade-union rules has only opened the way to quick results.

Intensive production, forced on us by war demands, is also demonstrating the value of systematic inspection and control of the quality of material. Without uniformity in material minimum labour costs are impossible. Times of operation, piece rates and certainty of regular output cannot be fixed when material varies outside of fixed limits. All output must be calculated with uniform quality of raw material guaranteed within reasonable limits, otherwise every calculation must be regulated by the occasional bad piece. The analysis, the physical test, the heat treatment, is the work of the scientific expert employed to keep things uniform, not to merely tell what is the matter after trouble comes.

The present crisis is permanently affecting (to the good of the nation) especially the man whose capital is in his brain and muscle. It is affecting him in two ways—through his military training in camp and field and through new shop conditions to which he is gradually accommodating himself. The high wages he is now receiving will be a blessing to all. They will never go back to the pre-war standard. Exactly what he will be when this crisis is over depends on how long the crisis lasts. If it lasts long enough, he will have learned that it is not to his own interest to do as little in a given time as possible, that he will be better off when he has learned his trade thoroughly and encouraged and helped others to become skilful craftsmen; that to be subject to discipline is not a degradation or a hardship, but a duty and a necessity to which all must submit; that he will always be the subject of suspicion and distrust unless he adheres to his written or spoken word; and that the happiness of one man at the expense of another is not good citizenship.

LITERATURE.

Discovery, or the Spirit and Service of Science. By Professor R. A. Gregory. London: Macmillan and Co., Limited. [Price 5s. net.]

In these days when the practical application of science to industrial purposes is urged with ever-increasing insistence, there is a danger that the more latent advantages attaching to scientific training may be underestimated, or confused with purely utilitarian objects. The pressing necessity of providing huge military equipment, and the evil consequences produced by undue reliance on foreign effort and enterprise for the supply of essential apparatus, have forced into prominence the effects of a criminal neglect of due precautions, whose results we are now feverishly anxious to diminish. In our eagerness to attain this end, we may err in our analysis of the causes that have contributed to our partial undoing and be led to seek a remedy from some superficial source, or to misapply the deductions from experience. As an all-sufficient remedy, the pursuit of scientific research and the adoption of scientific training have been invoked, but with exaggerated expectations and with undemonstrated possibilities of the method of action. It is well, therefore, that we should be reminded of the true meaning and aims of science, of its proper functions and influence, of its capacity and its limitations, of its benefits and rewards, drawing a sharp distinction between the commercial and the ethical side of research, between the love of truth and the love of material gain, between the satisfaction of an intelligent curiosity and the successful exploitation of a newly-discovered fact.

Professor Gregory's book is such a reminder, inasmuch as it compels us to question motive and to analyse results, placing in a more prominent position the consequences of the pursuit of science for its own sake. This review of some of the more obvious results is the more welcome as it is to be feared that much of the admiration that has been so suddenly lavished on science and scientific attainment has been prompted by unworthy, or at least not by the highest, motives. The results of science as they influence material welfare rather than its influence on character formation, or of the processes by which knowledge is attained and spread, have operated in the minds of many, however vehemently such bias may be denied. The author would clear our vision and make more evident the nature of the reward attaching to the search after truth. A nemesis of disproportion can easily follow where the pursuit of science is founded on other than disinterested motives. "When scientific work is instituted solely with the object of securing commercial gain," says the author, "its correlative is selfishness; when it is confined to the path of narrow specialisation it leads to arrogance; and when its purpose is materialistic domination, without regard for the spiritual needs of humanity, it is a social danger and may become an excuse for learned barbarity."

With the view of illustrating the scientific mind and of displaying the effect that the study of science exercises on individual character, Professor Gregory presents a number of mental pictures in which scientific students are seen carrying on their work, while appropriate quotations from their writings exhibit the spirit in which they contemplate their researches and indicate the goal which they hold worthy of attainment. Constancy of effort, unsparing sacrifice, singleness of purpose, are qualities we can all admire, though education and opportunity may prevent some from appreciating the precise difficulties of the task attacked, or the measure of success secured. It is not necessary to be an expert mathematician, a profound physicist or a trained biologist, to understand that the best interests of mankind are being forwarded by the patient workers who speak to us from these pages. They are men such as the world reverences for their devotion and self-sacrifice, they speak with equal authority and sincerity, and it is well to listen to their experience and to be guided by their teaching.

It should chasten our pride to remember that though we may hearken now to the words of a Darwin or a Huxley, and many another, there have been times when the leaders of popular opinion

have derided their conclusions and scoffed at their methods, so hard is it to escape from long-cherished preconceptions. The want of accurately trained minds, capable of recognising demonstrated truths, has prevented the teachings of science being accepted on their merits when in conflict with the standards set up by imperfect knowledge and obstinate prejudice. To condemn the new and the unfamiliar is an easy task, and may be a politic, when long-established authority is threatened, and it is one that always brings applause from the unthinking crowd. The burden that the pioneer has to shoulder is increased not a little by the hasty judgments and cheap sneers of the thoughtless and superficial.

To recall the opposition or the mistakes that have been made by self-sufficient authority is no part of the author's object, but it is impossible not to remember, when he sketches the history of some epoch-making discovery, that the attitude of schoolmen to scientific thought has not always been marked by the more tolerant, if somewhat grudging, sympathy that happily is apparent to-day. While grateful, however, for the improvement that marks the removal of the barrier of scepticism with which discovery was almost invariably opposed, it is impossible not to remember the bitterness that characterised the contest between the advocates of traditional learning and the newer school who would investigate the methods of Nature at first hand. Similarly, the work has little or nothing to say on the controversy which is still raging between what may be called the "vested interests" in education and the wider teaching of science in the schools and universities. While these subjects lie very near the surface and must be in the minds of all, the freedom from all controversial attitude is very much to be commended. In the true spirit of science, the author is not seeking for any polemical advantage. He has a message to convey and he supports it by clear and cogent evidence that all who run may read. Neither does he offer any tempting promises of reward to those who may be willing to pursue the scientific path of rigorous investigation. Of the practical side which looms so largely in many men's minds he has little to say, further than to insist on the inferiority of "usefulness" and "industrial application," in comparison with results that enlarge knowledge and widen our outlook into the mechanism of the Universe.

There is another side, or aspect, of the book, the historical, to which it is pleasant to make reference. It is necessary that Professor Gregory should tell or refer to many a tale of discovery that demonstrated the mastery that men had won over Nature, and which have thrilled men's minds as the consciousness of power or victory ever will. Frequent repetition has perhaps robbed some of these of their freshness, but the world still hears them with delight, and the author, touching them with a kindly but skilled hand gains from the accumulated details a chain of convincing evidence that satisfies the most critical judgment and ensures the consenting verdict for which he pleads.

A Text-Book of Practical Hydraulics, for the Use of Mining Schools, Technical Colleges, County and Hydraulic Engineers. By JAMES PARK, Dean of the Faculty of Mining Engineering at Otago University, N.Z. London: Chas. Griffin and Co., Limited. [Price 12*s.* 6*d.* net.]

A GLANCE at the contents of this treatise shows that the term "practical hydraulics" can be made to cover much engineering work with which water is only remotely connected. Bridge construction, dam-building, ditch-cutting, pipe-making, all receive some attention, apparently for the reason that such machinery is used in irrigation works, canals, drainage, &c., into which the control and direction of water enter. The author has had much experience in hydraulic installations, and the constructive details connected with these have absorbed his attention, and apparently have usurped the place that in an elementary work of this character would be better occupied by first principles. Such an extended view is necessarily accompanied by two defects. Very important matters closely connected with hydraulics are crowded out, as, for example, the whole theory of pumping, while the subjects that are introduced are discussed only in a superficial manner. Little satisfaction is to be found in the author's distinct assertion that no attempt has been made to invade the domain of hydraulic machinery, and little protection afforded by his reference of the student to standard works on divisions of the subject that clearly come within the purview of the treatise. Pelton's wheel, very well illustrated here, and turbine construction, are not more closely connected with hydraulic machinery than is the Humphrey pump, for example, but of this latter important invention and the principles it illustrates no mention is made.

In a work of this character, limited in size, selection becomes all important, and the merit of such a work depends much on the plan the author adopts. Mr. Park, writing with clearness and generally with accuracy, does not seem particularly happy either in his selections or his omissions. He does not draw sufficient distinction between students who need rigorous demonstration of the principles employed, and the engineer who, having completed a course of instruction in the laboratory, finds himself in charge of operations. To the latter, the results of accumulated experience are sufficient, and it is to this class that the author has the air of addressing himself, suggesting that a student, after rather indifferent preparation, may be suddenly called upon to undertake the conduct of engineering enterprises of considerable magnitude in very varied directions.

The contents follow somewhat stereotyped lines. The student is early introduced to the peculiarities in the flow of water through orifices and pipes, and led to estimate the effects of friction by means of well-known formulæ, extended to meet the conditions that arise when water flows over irregular, rough or porous surfaces. The tables and graphs given in these chapters, as in other parts of the book, should prove useful and time-saving to the practical engineer. The examples, usually of a very elementary character, are intended for the student, but are based on practical lines. Many of these involve the same data, treated by various empirical formulæ, and the comparison of the results is instructive, indicating the amount of reliance, or the limits of error, which may be anticipated. We may, however, point out that the number corresponding to Log. 1.46426 is not 2.912, but 29.12 (page 45). Such a result must be puzzling to the student, more especially as the cause of the error cannot be traced without reference to the original formulæ and a consideration of the units employed. This slip will no doubt be rectified in a later edition.

To these chapters follow descriptions of weirs, and the measurement of water flow by various current meters of special design. The information supplied is sufficient up to a certain point, but we were a little surprised that the author should suggest (page 98) that a tendency for the precipitation to fluctuate in cycles should be apparent where rainfall data over a number of years are available. The attempt to discover a cycle in rainfall statistics has proved a will-o'-the-wisp to many an investigator who has followed a hopeful trail, only to be baffled by puzzling combinations.

The following five chapters deal with constructive machinery for the guidance of water, whether in pipes and flumes or in open ditches, and the precautions to be observed in overcoming obstacles likely to be encountered in practice. Narrowly connected with the conveyance of water are the devices for securing efficient head by means of dams, whether of earth or solid masonry. In pursuing this subject Mr. Park attacks a series of problems whose practical applications are so many and varied that the space he is able to devote to their consideration is necessarily inadequate. The student may gather an insight into some of the difficulties that surround an important branch of hydraulic construction, but in actual practice would feel the necessity for wider information. Fortunately, the detailed description of many important undertakings by those who have brought them to a successful issue will supply the want and furnish desirable models. The author, aware of the perplexity and complicated character of these structures, would have done well to have provided a bibliography, for the necessary references would have proved a very useful supplement. The want of such guidance, particularly to the more matured student, will be also felt after reading the final chapter on Water Power and Prime Motors, in which reference is made to the Pelton water wheel and some typical forms of turbines. The illustrations, both here and throughout the book, generally are good and adequate. The working drawings, given on a fairly large scale, should prove a very helpful feature.

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United States Geological Survey. Mineral Resources of the United States, Calendar Year 1914. Part I., No. 3: *Silver, Copper, Lead and Zinc in the Central States in* 1914. By B. S. BUTLER and J. P. DUNLOP. Part I., No. 4: *Gold, Silver and Copper in Alaska in* 1914. By ALFRED H. BROOKS. Part I., No. 5: *Gold, Silver, Copper, Lead and Zinc in the Eastern States in* 1914. By J. P. DUNLOP. Part I., No. 6: *The Production of Manganese and Manganiferous Ores in* 1914. By D. F. HEWETT. Part I., No. 7: *The Production of Bauxite and Aluminium in* 1914. By W. C. PHALEN. Part I., No. 8: *Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in* 1914. By CHARLES W. HENDERSON. Part I., No. 9: *Gold, Silver, Copper, and Lead in South Dakota in* 1914. By CHARLES W. HENDERSON. Part I., No. 10. *Gold, Silver, Copper, Lead, and Zinc in Colorado in* 1914. By CHARLES W. HENDERSON. Part I., No. 11. *Quicksilver in* 1914: *Production and Resources.* By H. D. MCCASKEY. Part I., No. 12. *The Production of Platinum and Allied Metals in* 1914. By JAMES M. HILL. Part I., No. 13. *Gold, Silver, Copper, Lead and Zinc in California and Oregon in* 1914. By CHARLES G. YALE. Part II., No. 8: *The Production of Slate in* 1914. By A. T. COONS. Part II., No. 9: *The Production of Asbestos in* 1914. By J. S. DILLER. Part II., No. 10: *The Production of Mineral Paints in* 1914. By JAMES M. HILL. Part II., No. 11: *The Production of Fluorspar in* 1914, *with a Note on Cryolite.* By ERNEST F. BURCHARD. Part II., No. 12: *Sulphur, Pyrite, and Sulphuric Acid in* 1914. By W. C. PHALEN. Part II., No. 13: *The Production of Talc and Soapstone in* 1914. By J. S. DILLER. Part II., No. 15: *The Production of Mineral Waters in* 1914, *with a Historical Sketch of the Mineral Water Trade.* By R. B. DOLE. Part II., No. 16: *The Cement Industry in the United States in* 1914. By ERNEST F. BURCHARD. Part II., No. 17: *The Gypsum Industry in* 1914. By G. F. LOUGHLIN. Part II., No. 18: *The Production of Gravel and Sand in* 1914. By G. F. LOUGHLIN. Part II, No. 19: *The Production of Borax in* 1914. By CHARLES G. YALE and HOYT S. GALE. Part II., No. 20: *The Production of Salt, Bromine, and Calcium Chloride in* 1914. By W. C. PHALEN. Part II., No. 21: *Gems and Precious Stones in* 1914. By DOUGLAS B. STERRETT. Part II., No. 22: *The Production of Asphalt, Related Bitumens, and Bituminous Rock in* 1914. By JOHN D. NORTHROP. Part II., No. 23: *The Production of Lime in* 1914. By G. F. LOUGHLIN. Part II., No. 24: *The Production of Peat in* 1914. By CHARLES A. DAVIS. Part II., No. 25: *The Manufacture of Coke in* 1914. By C. E. LESHER. Part II., No. 26: *The Production of Silica in* 1914. By FRANK J. KATZ. Part II., No. 27: *The Production of Feldspar in* 1914. By FRANK J. KATZ. Part II., No. 28: *Statistics of the Clay-Working Industries in the United States in* 1914. By JEFFERSON MIDDLETON. Part II., No. 29: *The Production of Abrasive Materials in* 1914. By FRANK J. KATZ. Part II., No. 30: *The Production of Magnesite in* 1914. By CHARLES G. YALE and HOYT S. GALE. Washington: Government Printing Office.

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Public Works Department, Madras Presidency. Administration Report for the Year 1914–15. Part II.: *Irrigation.* Madras: Superintendent, Government Press. [Price 5*s.*]

New South Wales. Report on the Proposed Electric Railways for the City of Sydney. By J. J. C. BRADFIELD, M.E. Sydney: W. A. Gullick, Government Printer.

East Africa Protectorate. Annual Report for the Year 1914–15. By F. W. MAJOR, Chief of Customs, E.A.P. Mombasa: Customs Department. Nairobi: Government Printer.

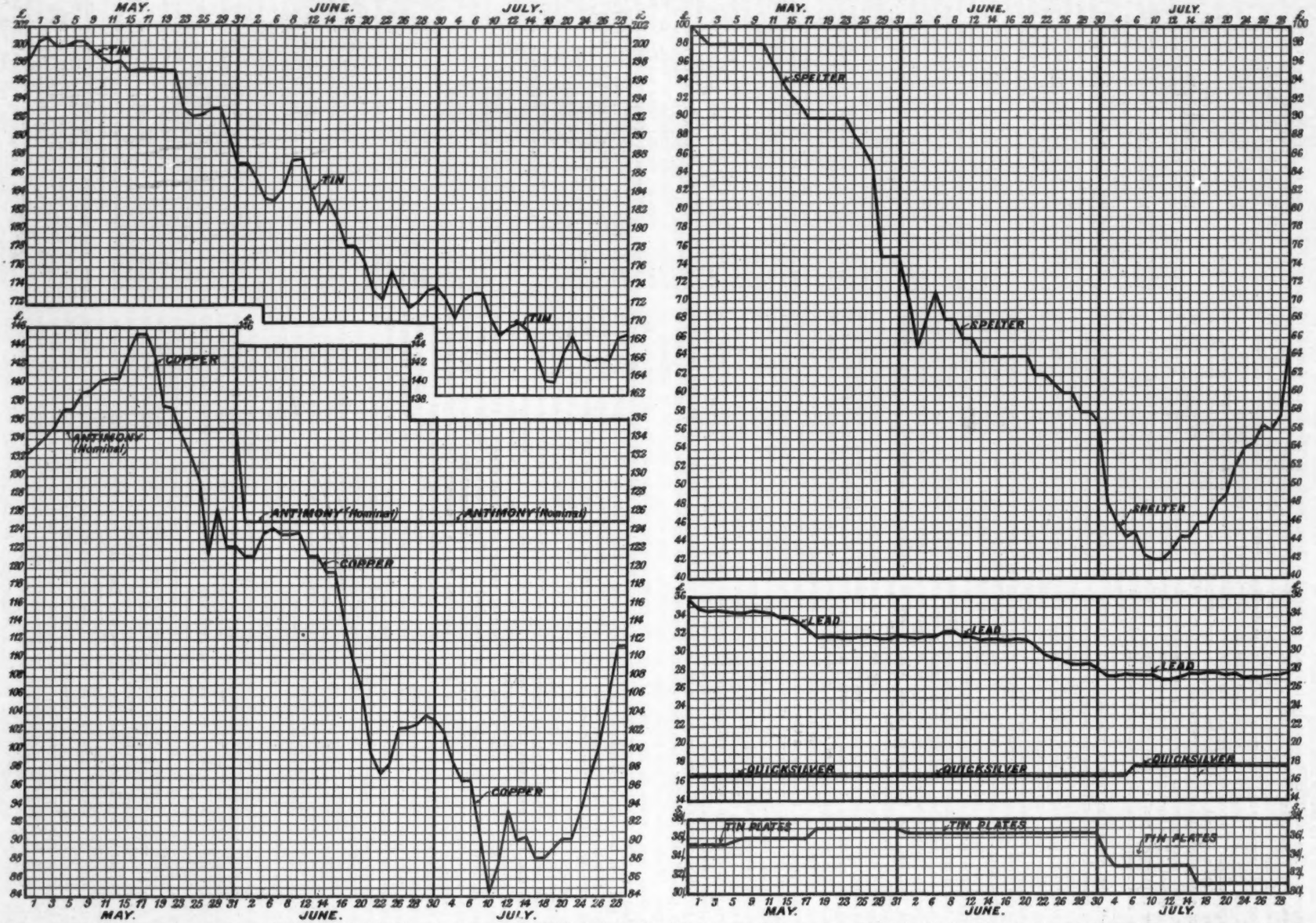
The Ship Painter's Handbook, with Useful Information for the General Painter and Decorator. By GEORGE S. WELCH. Third Edition, Revised. Portsmouth: Gieve's, The Hard; London: John Hogg, 13, Paternoster-row. [Price 3*s.* 6*d.* net.]

Harper's Hydraulic Tables for the Flow of Water in Circular Pipes under Pressure, Timber Flumes, Open Channels, and Egg-Shaped Conduits. By JOSEPH H. HARPER. London: Constable and Co., Limited. [PRICE 8*s.* 6*d.* net.]

Trade as a Science. By ERNEST J. P. BENN. With *Introductory Preface* by the Rt. Hon. Lord BURNHAM. London: Jarrold and Sons. [Price 2*s.* 6*d.* net.]

THE ENGINEERING STANDARDS COMMITTEE.—At a special meeting of the Main Committee (Sir John Wolfe Barry, K.C.B., Chairman) held on July 27 last, Mr. Charles le Maistre, A.M.Inst.C.E., M.Inst.E.E., who has been in charge of the work of the Electrical Section since 1903, was appointed Secretary to the Engineering Standards Committee in succession to the late Mr. Leslie S. Robertson, M.Inst.C.E., who was lost with Lord Kitchener in the disaster to H.M.S. Hampshire whilst on an important Government mission.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.



NOTE.—In the diagrams on the present page the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for "fine foreign" and "standard" metal respectively. The prices plotted for antimony and lead are for English metal in both cases, while those for spelter are for American metal—the only kind at present available; these prices are per ton. At the close of the Glasgow Iron Market on the 31st May a notice was posted up stating that "owing to the action of the Minister of Munitions, the Glasgow Pig-Iron Warrant Market is suspended till further notice." After that date quotations were nominal at the prices which then prevailed—viz.: Hematite, 6*l.* 2s. 6d.; Scotch, 4*l.* 8s. 6d.; and Cleveland, 4*l.* 2s. 6d. per ton. On July 7, however, the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig is fixed at 6*l.* 2s. 6d., Scotch 5*l.* 14s. and Cleveland 4*l.* 11s. 6d. per ton.

Ship-plates were priced at 11*l.* 10s., and heavy steel rails at 10*l.* 17s. 6d. per ton. These official regulations were quoted in full on page 45 in our issue of the 14th ult.

DESIGN OF A RAILWAY PONTOON BRIDGE.*

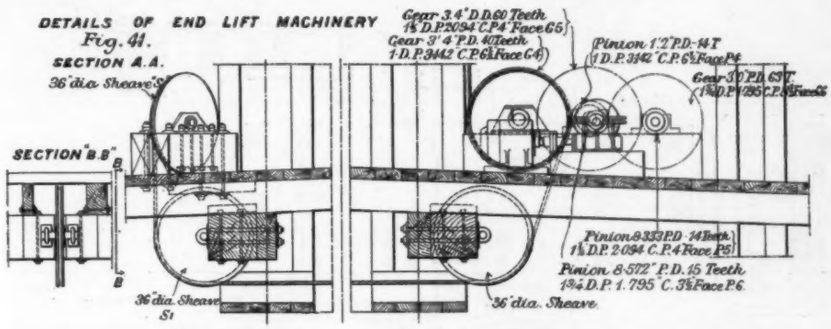
By H. J. HANSEN, M.W.S.E.

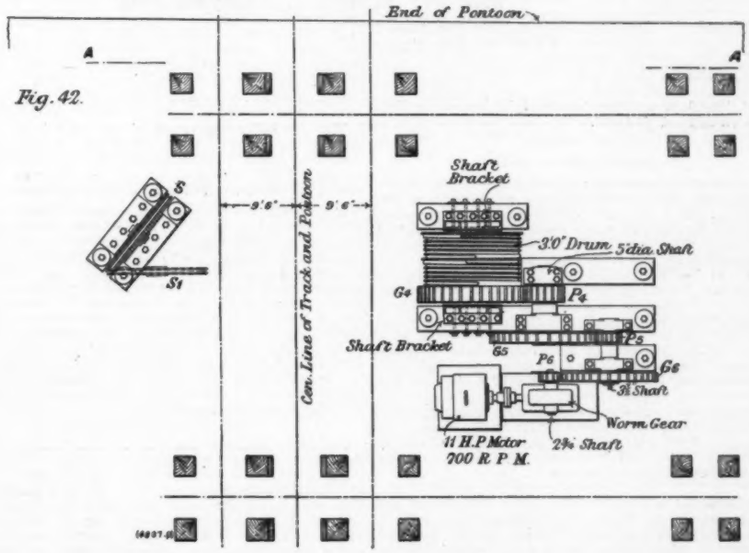
(*Continued from page* 94.)

THE new pontoon now being constructed for the west channel to replace the present 405-ft. structure is 276 ft. 4 in. long, 55 ft. wide at deck, 44 ft. wide at the bottom and 7 ft. 2 in. deep at the centre. The clear waterway required is 225 ft., which is a reduction of 130 ft. from previous requirements.

This pontoon is of the same general type as the new east channel pontoon and is designed to carry Cooper's E-50 loading modified to include only one locomotive. The aim in this design has been to provide adequate stiffness, to prevent excessive rocking due to wind and waves, and to provide machinery for operating the floor and end lifts.

Figs. 10 and 11, Plate XI, show the arrangement of this bridge, and Fig. 12 the general arrangement of the pulling chain. The structural details are shown in Figs. 13 and 14. Some details of the pontoon are given in Figs.





15 to 18; Fig. 15 is a cross section at L3-U3, Fig. 13; Fig. 19 is a cross section at all panel points except L1 and L3, and Fig. 21 is a cross section between panel points.

The four longitudinal trusses are proportioned to resist the bending and shear forces in that direction, the inside trusses carrying about two-thirds of the live load, and the outside trusses the remaining one-third, the transverse shear between the two trusses being transmitted by the vertical transverse bracing at each panel point.

The web members of the trusses consist of vertical posts and diagonal adjustable rods. The vertical struts are composed of four 8-in. by 8-in. or in some of the panels four 8-in. by 10-in. timbers spaced 1 ft. 4 in. apart in a longitudinal direction, so as to serve the double purpose of guiding the floor beams and to act as compression members. The chords are composed of 8-in. by 16-in. timbers packed and spliced with the company's standard Howe truss packing washers and splice clamps, both top and bottom chords being treated alike in this respect on account of the reversal of stress. The stress between the diagonal rods and the chords is transmitted through cast-iron bearing blocks having lugs notched into the chords to carry the horizontal component. The stress between the vertical posts and the chords is transmitted through oak sills and caps dowelled to both the chords and the posts. These oak blocks were chosen on account of their high bearing value, it being found that in most cases the bearing value of Douglas fir perpendicular to the grain was inadequate to meet requirements.

The transverse bracing is designed to resist the forces produced in this direction by latching the pontoon at top and bottom to prevent rolling. Web members in both the vertical and horizontal bracing are composed of diagonal timber struts for compression members and upset steel rods for tension members, connected to the trusses with cast-iron angle blocks. The horizontal component of the stress is transmitted to the scow through an angle block, a strut and castings having lugs notched into the cross girder and being held in place by bolts through this timber (Fig. 19). To ensure a bearing between the vertical post and the casting *c*, the latter is accurately located and bolted in place before the tension rods in the vertical bracing are tightened. When the nuts are screwed up on these rods, the bottom diagonal struts will force the vertical posts against the castings, thus completing the truss system and connecting up with the transverse bracing below the deck.

The joists are 4 in. by 12 in. except at the panel points, where 8-in. by 18-in. timbers are used in the transverse bracing, and the middle joists in each panel, which are 8 in. by 12 in., to receive the butt joints of the sheathing. A smaller depth of joists would be sufficient both for stiffness and strength, but the 12-in. depth is necessary in order to provide clearance for the cast-iron bearing blocks and for turning the nuts on the diagonal rods. The sheathing is 4 in. thick and, except for special shapes, is composed of 4 in. by 10 in. planking. The scow is caulked on all sides and the sheathing is bevelled for caulking as shown in Fig. 18. This view also shows the methods of rabbeting and bevelling the end joists for caulking. After the joints have been caulked with oakum, caulking strips are nailed on the top of the oakum to prevent it from working out. All the timber in the pontoon is creosoted except the sheathing, the oak blocks and the machinery supports. The sheathing is not creosoted, as previous experience shows that the creosoting process, which has a tendency to soften the wood, makes it impossible to obtain a perfect caulking seam. It was therefore decided to paint the sheathing with carbolineum after the pontoon is completed instead of creosoting it.

On the up-stream side the scow is protected against the scouring of ice by ½-in. steel plates bolted and nailed to the sheathing as shown in the cross-sections.

The floor system shown in Figs. 26 and 27, Plate X, consists of shallow steel floor beams and timber stringers connecting up with a 50-ft. hinge span at the panel point L3 at each end of the pontoon.

The floor beams are supported on blocking piled between the vertical posts of the inside trusses. This blocking rests on the oak bearing blocks *e*, Figs. 22 and 23, which transfer the load to the short struts *f* supported on the oak bearing blocks *g* of the inside trusses.

The track is kept lined up horizontally by timber blocks bolted to the floor beams and guided by the vertical posts. Vertically the track is regulated by varying the number of supporting blocks under the floor beams.

The stringers consist of two lines of three 10-in. by 18-in. timbers bolted together. They are supported between the floor beams on shelf angles and lined up horizontally by lugs bolted to the shelf angles. The stringers are not bolted to the floor beams, and their ends are cut on a bevel to allow a certain amount of relative movement of the floor beams in a vertical direction. This precaution is necessary in order to adjust the track by jacks temporarily in case the floor lift machinery should get out of order.

The 50-ft. hinge spans are of the ordinary through type plate girder spans with shallow floor, and serve to connect the approach track with the track on the pontoon draw. The pontoon track is elevated about 1 ft. above the approach tracks, and the hinge spans are on a grade of about 2 ft. in 100 when the bridge is unloaded. When a train approaches the pontoon, a gradual displacement takes place until the hinge spans are approximately level when the bridge is fully loaded.

The abutment ends of the hinge spans are provided with rocker shoes, pin-connected to the girders, and swinging with the girders when the bridge is opened. The pontoon ends of these hinge spans are supported on and riveted to cross girders at the panel points L3. The ends of these cross girders are provided with pin-connected shoes and supported on blocking confined between the vertical posts at L3, similar to the blocking system for the intermediate floor beams. Enough space is left between the cross girders and the posts to allow for a certain amount of rotation about the shoe pins due to live-load displacement. The abutment ends of the hinge spans are lifted off of their supports and the spans are carried entirely on the pontoon when the bridge is opened.

The variation of the water level in the Mississippi River is quite considerable, the difference between the extreme high and extreme low water being approximately 22 ft. This extreme difference, however, does not occur very often, and our records show that it has not occurred since 1880, the ordinary yearly variation being only 12 ft. to 16 ft., and the maximum daily variation 3 ft. Fig. 33, Plate XII, shows graphically the weekly variation of the water stage of the Mississippi River at the bridge site during 1912. Provision is made for regulating the track over a range of 16-ft. rise and fall of the river. When the water rises to a higher stage than from 16 ft. to 17 ft. above the zero mark, the approaches have to be raised.

On account of the heavier loading for which this bridge is designed, the floor system is too heavy to be conveniently or economically handled with jacks, and, therefore, electrically operated machinery is provided for adjusting the track. The floor lift machinery is shown in Figs. 24, 25, Plate X, 34 and 35, Plate XII. The track is raised or lowered relative to the pontoon deck by suspending the floor beams from thirty-four ¾-in. steel cables winding on thirty-four cast-iron drums. These drums are mounted on two longitudinal drum shafts, one on each side of the pontoon, and each of these shafts is driven by a separate back-geared motor through a train of reduction gears. The entire floor system is held in any required temporary position by two brakes operated by a lever in the operator's house.

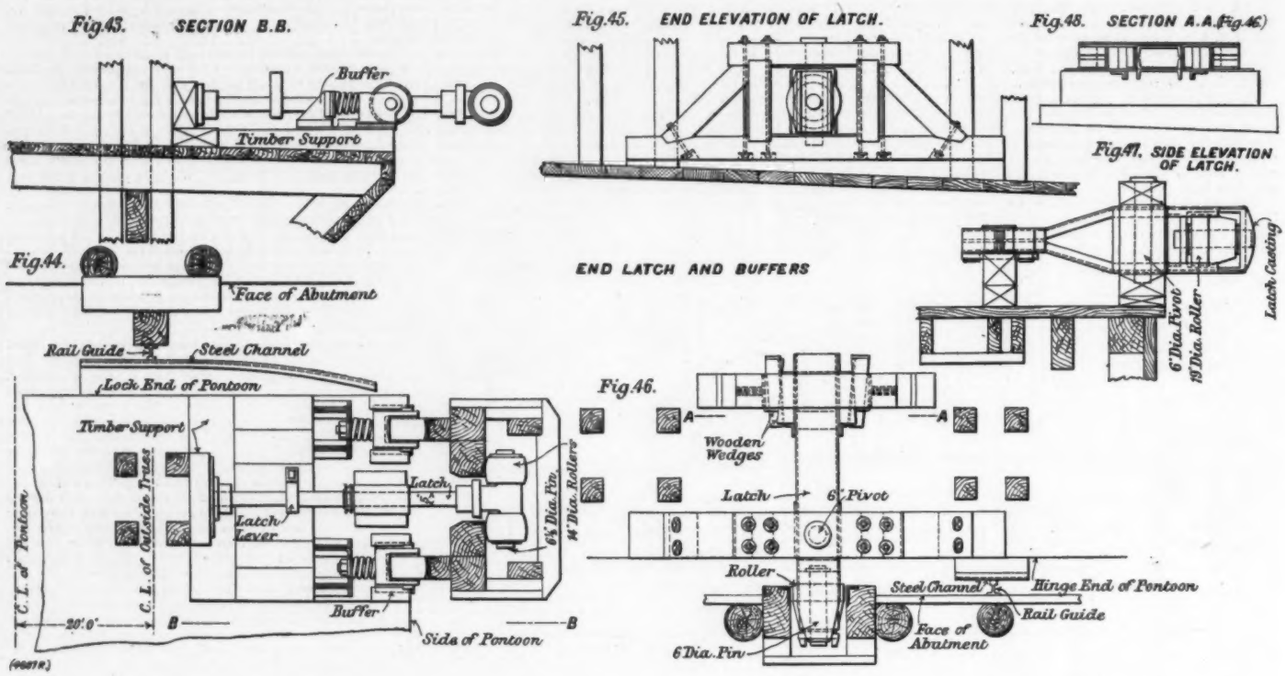
The hoisting cables are connected to adjustable U-bolts at the under side of the top chords, and they are doubled by leading them through loose sheaves running between brackets connected to the top flanges at each end of the floor beam. The cables are then led over loose sheaves on the top of the top chord to the drums.

The load suspended at each cable is 5,000 lb., and by doubling the cables as just described the direct stress in each part is reduced to 2,500 lb. The loads at the panel points L3 are considerably more than at the intermediate floor beams and are counterweighted in order to reduce the loads carried by the hoisting cables at these four points to about 3,000 lb. Details of cable connections are shown in Figs. 36 to 40, Plate XII. The two drum shafts are located one on each side of the pontoon between the outer and inner trusses. Each shaft is 198 ft. 6 in. long and extends from the panel point L3 at one end to the corresponding panel point L3 at the other end. The shafts are built up of short sections, one panel in length, connected by flange couplings and decreasing in size from 5½ in. in diameter at the centre to 3½ in. in diameter at the ends. They are supported on two babbitted bearings at each panel point, the bearings being located at each end of the cable drum, which is keyed to the shaft at these points. The cable drums are 14 in. in diameter and 15 in. long, and grooved to receive the cable. Each drum is of sufficient length to receive a maximum length of cable to be wound up when the floor is in its highest position without doubling the layers of cable on the drum.

Each of the drum shafts is operated by one 11 h.p. direct-current back-geared electric motor. These motors transmit motion to the drum shafts through three pairs of reduction gears and are connected electrically to ensure simultaneous action on both sides. The gears operating the drum shafts are located at the centre of the shafts in order to reduce the twisting moment. The friction brakes are located on the gear shaft next to the motor shafts in each train of gears. They are connected by the equalising lever to ensure an equal amount of braking power at each shaft and are applied by releasing the counterweights on the brake-lever arms. Both

* Paper read before the Western Society of Engineers, U.S.A.

RAILWAY PONTOON BRIDGE ACROSS THE MISSISSIPPI RIVER.



brakes are operated simultaneously by the lever in the operator's house.

The arrangement of the machinery for lifting the abutment ends of the hinge spans off the abutment supports when the bridge is to be opened is shown in Figs. 41 and 42, page 115. It consists of two steel cables, from which the girders are suspended, winding on a cast-iron drum driven by an electric motor through a worm and two sets of spur gears.

The hinge span is suspended from the two steel cables, one on each side of the span, by loose sheaves connected to the outside of the girders near the abutment ends. These cables then are led over loose sheaves on the top of the top chords to a cast-iron drum located on the deck. This drum is driven with an electric motor through a train of reduction gears.

The hoisting cables are connected to an adjustable U bolt in the ends of the top chords extended beyond the trusses for this purpose. The cables are then passed under the loose sheave and led over the loose sheaves on the top of the top chord to the cast-iron drum. Both cables are wound on one double drum located on one side of the track, and the cable from the opposite side is led to the drum by passing it across below the pontoon deck.

Each hinge span is lifted by separate 10-h.p. electric motors located at each end of the pontoon and operated by separate controllers. The motors impart motion to the cable drum through a worm and a train of three pairs of spur gears. The worm not only serves as a speed reducer, but also holds the load in any position at which the power is cut off.

The electric power for operating the floor lift and end lift machinery is furnished by a 25-kw. generator placed on the pontoon and receiving its supply of steam from the boiler that furnishes steam for swinging the bridge.

The arrangement of the swinging machinery is shown n Figs. 24 and 25, Plate X. It consists of the 70-h.p. engine from the old bridge, which is operated as previously described, except that the machinery is located on the pontoon instead of on a separate scow. The pontoon is rotated about a hinge pile composed of heavy wrought-iron pipe fitted around a wooden pile. The hinge pile is braced to the hinge pier by movable steel straps. The time required to open or close the pontoon 90 deg. is about 5 minutes, including the time required to lift the girder ends off the abutments.

To keep the rails of the draw and approaches in line, the track at the hinge end is provided with a V-shaped catch, and at the free end with counterbalance weights as shown in Fig. 27, Plate X., and previously described for the old pontoon; in addition the pontoon is held in position by latches at the deck level and in the plane of the top chords, as shown in Section AA, Fig. 28. At the hinge end the latches are adjusted by wedges, so that when the pontoon is closed, they slide in position between the vertical guides. At the free end the T-shaped button fasteners must be turned by hand in order to lock or unlock the bridge. The top latches are used only in rough weather to prevent rocking and transverse rolling of the bridge. Spring buffers are provided at the free end to relieve the shocks from rocking and by closing of the bridge. The bridge is also guided in a longitudinal direction, and the details of latches and buffers are shown in Figs. 43 to 47.

(To be continued.

Bethlehem Blast-Furnace Output.—According to the *Iron Age*, the record for daily production at the Bethelehem Steel Company's blast-furnace department was broken on June 28, when 2,961 tons of pig-iron was produced in 24 hours. The highest previous record, made on April 19, was 2,931 tons.

American Steel Exports.—Mr. K. A. Orbanowski has become Treasurer of the American Steel Export Company, which was organised in June, 1915, by officials of the Cambria Steel Company. Mr. Orbanowski is a member of the Institute of Naval Architects of Great Britain and the Society of Naval Architects and Marine Engineers of the United States. Mr. S. A. Benner has also joined the American Steel Export Company. He was formerly associated with the Carnegie Steel Company and became foreign sales manager for that company at Pittsburg in 1900. Mr. G. A. Harris has taken charge of the Engineering and Machinery Department of the American Steel Export Company.

Compressibility of Natural Gas.—The natural gas used in the United States is sometimes measured at pressures of 40 atmospheres (600 lb. per sq. in.) and commonly at pressures of about 25 atmospheres, the assumption tacitly made being that the gas will obey Boyle's law, although it is fair to presume that the natural gas does not behave like an ideal gas and is more compressible at higher pressures than at atmospheric pressure. The subject has been investigated on behalf of the Bureau of Mines by Messrs. G. A Burrell and I. W. Robertson (Technical Paper No. 131). It has been found that the gas is eleven times more compressible at 25.6 atmspheres (375 lb. per sq. in.) than at atmospheric pressure, the consequence being that 11 per cent. more gas is recorded by the meters at that pressure than is actually being received. At 35.5 atmospheres the difference amounted to 15 per cent. The experiments were made on Pittsburg gas and on seven other natural gases, from New York, Ohio, Kentucky and Oklahoma. The Pittsburg gas contained 0.7 per cent. of moisture, and when deprived of this water, 84.7 per cent. of methane, 9.4 of ethane, 3.0 of propane, 1.3 of butane, &c., and 1.6 of nitrogen; the analyses of the other natural gases were not so complete; the nitrogen percentage ranged up to 6.6. The compressibility of methane had been investigated by Amagat, but only for the range 39 to 290 atmospheres, methane proving 9 per cent. more compressible at 40 atmospheres, and 17 per cent. more compressible at 100 atmospheres than at 1 atmosphere. There were no exact data available about the compressibility of the other hydrocarbons. The new experiments suggest that those hydrocarbons deviate still more from Boyle's law than methane, and the figures we have given show that a company, buying natural gas at high pressure and distributing at low pressure, may use considerably more gas than it pays for.

COLONIAL ENGINEERING PROJECT.

We give below some particulars concerning a colonial engineering project, taken from the *Board of Trade Journal*. Further information on this project can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

New Zealand.—According to an extract from the local Press, forwarded by H.M. Trade Commissioner in New Zealand a recent report by engineers recommends the proposed extension of the Dunedin water supply by bringing the Lee Stream water into that city. The proposed work involves the completion of the partially driven tunnel at the Lee Stream and by means of this and a line of pipes to convey the water of the Lee Stream to the southern reservoir above the Kaikorai Valley. The estimated total cost of this scheme is 128,738*l.*, of which 18,956*l.* is allotted to the boring of the tunnel; 2,750*l.* to the intake weir, &c.; 5,000*l.* to lining of tunnel; 94,932*l.* for steel pipes; 2,000*l.* for a bridge across the Taieri River.

Canadian Pacific Railway.—The Canadian Pacific Railway Company is arranging for a great winter season at St. John, New Brunswick. It is proposed to instal additional trackage space in the west side freight yard. This will bring the total yard accommodation up to 1,850 cars. All light rails now in use are to be replaced by 85-lb. rails. A new coaling plant is to be erected and a 20,000,000-gallon fresh-water tank to be put in. The capacity of the sidings between St. John and Montreal is to be generally increased.

Gold.—The imports of gold coin and bullion into the United Kingdom in the six months ended June 30 this year were valued at 6,366,896*l.*, as compared with 6,010,211*l.* in the first half of 1915, and 28,934,112*l.* in the first half of 1914. In these totals imports from the United States figured for 1,201,874*l.*, as compared with 24,842*l.* and 18,305*l.*; imports from Brazil for 253,402*l.*, as compared with 3,588,915*l.* and 2,574,198*l.*; imports from Egypt for 76,339*l.*, as compared with 297,892*l.* and 2,495,821; imports from Rhodesia for 752,704*l.*, as compared with nil and 488,916*l.*; and imports from the Transvaal for 2,829,392*l.*, as compared with nil and 16,727,225*l.* Imports have naturally been reduced by the difficulties attending deliveries.

The Suez Canal.—The tonnage passing through the Suez Canal last year decreased to 4,143,340 tons, as compared with 4,767,729 tons in 1914. The revenue collected declined from 5,026,037*l.* in 1913 to 4,889,954*l.* in 1914 and 3,740,905*l.* in 1915. The number of ships which passed through the canal last year was 3,708, or 904 less than in 1914. The number of British vessels which used the Canal in 1914 was 3,078, of an aggregate of 12,910,278 tons; in 1913, 2,736 vessels, aggregating 11,656,038 tons, passed through the waterway. The German tonnage using the canal declined from 3,352,287 tons in 1913 to 2,118,946 tons in 1914; while in 1915 there was, of course, a complete cessation of German traffic.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

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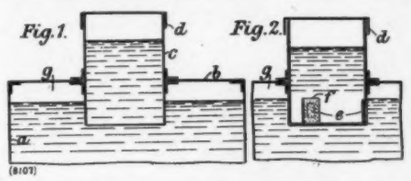
ELECTRICAL APPARATUS.

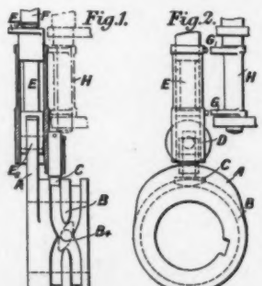
8107/15. The British Electric Transformer Company, Limited, and W. McWilliam, Hayes. Oil-Cooled Transformers. (3 *Figs.*) June 1, 1915.—The object of the present invention is to secure the advantage of as little exposure of the oil to the atmosphere as possible, with greater compactness of apparatus than heretofore, and it is achieved by employing a pipe or trunk extending downwardly into the oil-container and also upwardly above the cover, the arrangement being such that oil can pass to and from the pipe or trunk with a so-called breathing action. A casing *a*, having a cover *b*, is provided with a trunk *c*, extending downwardly into the casing



and also extending upwardly above the cover *b*. This trunk *c* may be open-ended at the bottom, as shown in Fig. 1, or closed and formed, as shown in Fig. 2, with one or more side openings *e*, *f*. By appropriate determination of the depth to which the trunk *c*, shown in Fig. 1, descends into the casing, or the height of the upper edges of the openings *e* in the trunk, shown in Fig. 2, a sealed air space *g* results when oil is introduced into the casing through the trunk, any desired liquid head being obtained, dependent upon the length of the trunk *c*. With such an arrangement the oil can, with increase of temperature, be accommodated in part by the sealed air space *g*, and in part by the trunk *c*, to and from which it can pass with what may be described as a breathing action. (*Sealed.*)

GAS-ENGINES, PRODUCERS, HOLDERS, &c.

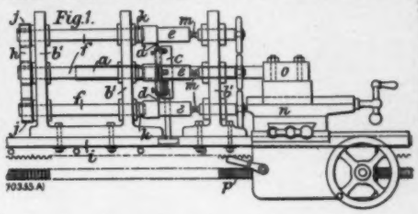
10,011/15. Sunbeam Motor-Car Company, Limited, L. Coatalen, and H. C. M. Stevens, Wolverhampton. Internal-Combustion Engines. (2 *Figs.*) July 9, 1915.—In valve-operating mechanism for four-stroke internal-combustion engines, there is a type of mechanism which obviates the use of half-time gearing. In this type there is a single lifting cam which engages an axially movable tappet for the operation of the valve. To prevent the tappet rising at every revolution of the cam the tappet is actuated by a separate scroll cam, so that it is moved out of the plane of the lifting cam during one revolution and into the plane of the cam during another revolution or part thereof. According to the present invention, the tappet guide is provided with a bearing which is parallel to the axis of the tappet, and it swings bodily transversely to the cam instead of swinging pendulum fashion. The lifting cam A is combined with a grooved cam or scroll B, comprising two grooves B^2, B^5, lying side by side, and of the same diameter,

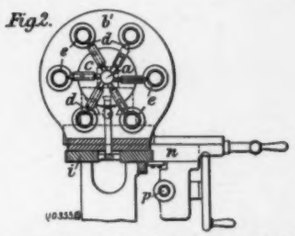


if desired, with a cross-over B^4 at one point. In this groove lies a slipper C connected with the tappet guide D containing a tappet E. As the cam A B revolves, the guide D will be moved laterally. Thus, during one revolution, the slipper C will lie in the groove B^2 and the tappet E will be in the plane of the cam A. Consequently the swell of the cam will raise the tappet and cause it to lift the valve stem F. On the next revolution, the slipper C will have moved into the groove B^5 and the guide D and tappet E will have been swung bodily to the right out of the plane either of the cam A or the valve stem F, or both. For this purpose, the guide D is supported on a pair of links G, from a pivot H which is parallel to the tappet E, these parts being shown dotted in Fig. 1 because they lie behind the tappet E in that view. Preferably the tappet carries a narrow roller E^2, which runs upon the face of the cam A, and it is merely necessary to move the tappet a short distance from side to side to cause it to engage and disengage the cam, and the top of the tappet is provided with a head E^3, so that this part always remains beneath the foot of the valve stem F. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

10,355/15. E. Hamilton and John Hamilton and Sons, Limited, Salford. Turning Metal Blanks. (3 *Figs.*) July 16, 1915.—This invention relates to apparatus for turning a number of metal shell blanks at one time. A slidable and non-rotating boring bar *a* is mounted in bearings in frames b^1 and provided with a cutter head *c*, in which can be located cutting tools *d* corresponding in number with the metal blanks *e* to be

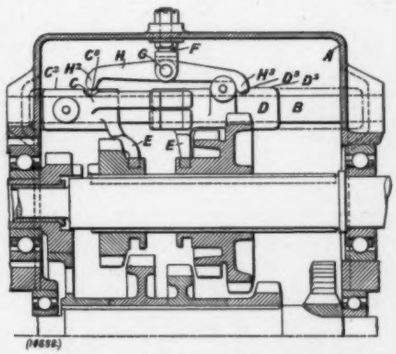




turned. Surrounding the boring bar *a* is a number of spindles *f*, also mounted in bearings in frames b^1. The spindles are driven. Each spindle *f* is arranged to support one end of the blank *e* to be turned, the other end of the blank being supported by a centre *m*. Convenient means are adopted for traversing the boring bar between the blanks for the purpose of turning the latter on their exterior surfaces simultaneously. (*Accepted May 17, 1916.*)

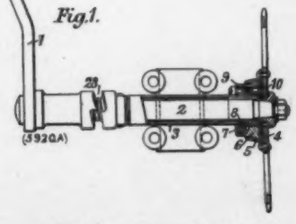
MOTOR ROAD VEHICLES.

14,688/15. Humber, Limited, and F. T. Burgess, Coventry. Change-Speed Gearing. (1 *Fig.*) October 18, 1915.—This invention provides simple means for locking the sliding sleeves of change-speed gearing. There is arranged lengthwise in the gear box A a bar B, upon which slide two sleeves C and D, each of which carries a striking-fork E. One face of each of these sleeves is formed flat at C^2 and D^2, except at one point in each where a notch at C^3 and D^3 is provided. Adjustable along the side of the gear box is a stud F, on which is pivoted a rocker H, the ends of which are curved



to form catches H^2 and H^3, which engage notches C^3 and D^3. When correctly adjusted, the rocker H engages one notch, say D^3, fully at one end, whilst the other extremity, H^3, lies just out of the corresponding notch and about flush with the face C^2 of the sleeve C. The sleeve C can then be moved along the bar B, in which case the flat face C^2 prevents pivoting of the rocker and consequent disengagement of the end H^3 from the notch D^3. The sleeve D is therefore positively locked. By this means, whilst one sleeve is being moved, or is out of the neutral position, the other is locked. (*Sealed.*)

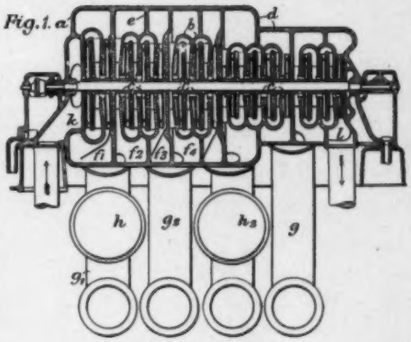
5920/15. The Enfield Cycle Co., Ltd., and R. W. Smith, Redditch. Motor Cycles. (2 *Figs.*) April 20, 1915.—According to this invention, a starting device for motor cycles has a primary starting handle, adapted to be rotated continuously,

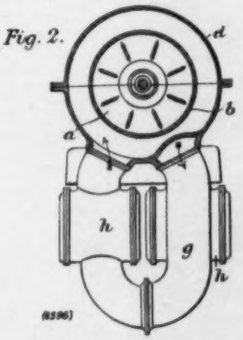


and in an unlimited degree, in which means are provided whereby after the operation of the primary starting member has been discontinued, said primary starting member or a part thereof is caused to rotate in a rearward direction in such a manner as to bring about the retention of the parts of a starting clutch normally out of contact or engagement. 1 is a starting handle which is adapted to impart rotary motion to a shaft 2. The shaft 2 carries a chain wheel 4 which carries the female member 5 of a coned friction device. The male member 6 of this coned friction device encircles the sleeve 3 and is furnished with an internal annular groove in which a coiled spring is disposed in such a manner as to be compressed in a circumferential direction. The arrangement is such that when the shaft 2 is rotated by the starting handle 1, the member 6 is first of all rotated a part of a revolution against the resistance of the coiled spring, this occurring by reason of frictional engagement between the parts 5 and 6; but after the spring has been compressed to a certain extent, the part 6 slips in relation to the part 5, at the same time retaining the latter in the position to retain the spring compressed, so that the spring is retained in its compressed condition throughout the time during which the shaft 2 is rotated. When the handle 1 is released, the spring expands and causes the chain wheel 4 to rotate to a small extent in the opposite direction. The chain wheel 4, shaft 2, and handle 1 constitute the primary starting device, and the chain wheel 4 and shaft 2 together constitute the part of the primary starting member which, after starting, is caused to rotate in a rearward direction. (*Sealed.*)

PUMPS.

6596/15. Aktiengesellschaft Brown, Boveri et Cie., Baden, Switzerland. Centrifugal Compressors. (2 *Figs.*) May 5, 1914.—This invention consists in surrounding the compressor proper with a hollow body without increasing the over-all length of the compressor in any way, which body is subdivided into consecutive chambers in or from which the compressor stages deliver or receive the air, which chambers are connected with intermediate coolers by means of exhaust and entrance passageways. The centrifugal compressor *a* is provided with a casing *b* for various wheels *c*, which are combined together to form separate wheel groups. The whole is enclosed in an outer casing *d* divided by partitions *e* into separate chambers f^1, f^2,





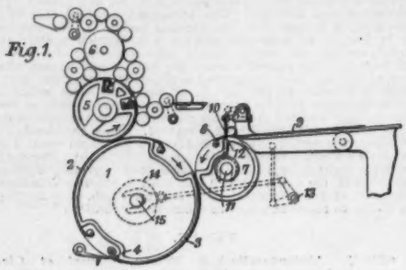
&c. The several wheel groups communicate with these chambers in such a manner that they suck from one chamber and deliver into the next one of the series. The various chambers are connected in proper sequence by pipes *g*, g^1, &c., which contain coolers *h*, h^1, &c. In operation, the fluid passes from the suction pipe *k* into the compressor, and is delivered by the first wheel group into the first delivery chamber f^1, whence it passes by pipe g^1 into the cooler h^1. From the cooler h^1 it passes into the suction chamber f^2, whence it is delivered by the second wheel group into the delivery chamber f^3, and so on until it leaves the machine in a compressed state by the delivery pipe *l*. (*Sealed.*)

PRINTING AND ALLIED MACHINERY.

13,793/15. R. Hoe and Co., Limited, London. Printing Machines. (3 *Figs.*) September 28, 1915.—This invention comprises the combination with a cylinder having a planographic printing surface and a non-impression sheet-receiving surface, of a design carrying cylinder for delivering the design to the printing surface, a flat delivery co-operating with the sheet-receiving surface to which the sheets are delivered printed side up from the sheet-receiving surface, and impression means which co-operates to print the sheet and delivers it to the sheet-receiving surface. 1 indicates a printing cylinder having a printing surface 2 and a non-impression sheet-receiving surface 3. The printing surface 2 is a planographic surface. When the invention is embodied in a transfer printing machine, a design-carrying cylinder 5 will be provided, this cylinder receiving ink from the battery 6. This design-carrying cylinder is arranged to make two revolutions to each revolution of the cylinder 1, thus causing the design to pass the inking rolls twice, so that the ink may be thoroughly worked into the design. The impression means consist of a cylinder 7, which is arranged to make two revolutions to one of the cylinder 1. On the first revolution, the cylinder 7 co-operates with the printing surface 2 and effects the printing, and on the second revolution it co-operates with the sheet-receiving surface 3 and delivers the sheet thereto. Sheets are delivered to the cylinder 7 from a feed-board 9. The flat delivery mechanism employed consists simply of tapes 16 running over the ordinary tape rolls 17. In the construction described, the sheets are fed from the feed-board

9 to grippers on the cylinder 7, and as this cylinder makes its first revolution, the sheets are printed, the position of the parts being shown in Fig. 2. As the cylinder makes its next revolution, the sheets are delivered from the grippers on the cylinder 7 to grippers on the cylinder 1 and are laid against the sheet-receiv-

Fig.1.



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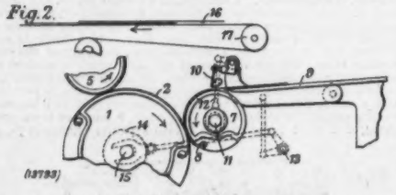
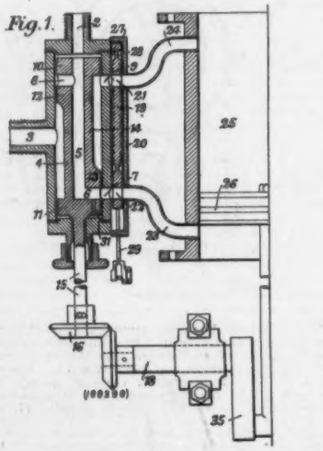


ing surface 3, the printed side of the sheets being toward the surface. As the cylinder 1 continues its revolution, the grippers are opened and the sheets deposited printed side up on the tapes 16. It will be seen that the sheets are carried directly through the machine and delivered printed side up without any change in their direction of movement. (*Sealed.*)

STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

100,290. G. M. Addison, Bristol. Valve Mechanism. (14 *Figs.*) January 24, 1916.—According to this invention, valve mechanism for steam engines consists of a rotary distributing valve actuated from the crank-shaft of the engine and in sequence therewith, and a reversing slide valve actuated separately for controlling the admission and emission of steam to and from the cylinder and the distributing valve. In the cylindrical valve casing 1 is a cylindrical distributing valve 4 constructed with a central passage 5 and branches 6 and 8. The top and bottom portions 10, 11 of the valve 4 are cylindrical and fit the valve casing 1. The valve 4 has a rod 15, carrying at its end a bevel wheel 16, meshing with another bevel wheel carried by the crank-shaft 18. One side of the valve casing 1 has a flat face, and next to this is positioned the reversing valve 19, which is held in position by the casing 20. This reversing valve 19 is

Fig.1.



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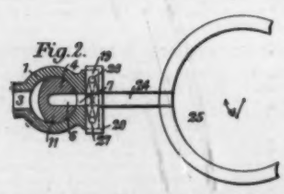
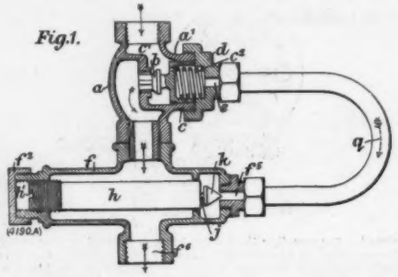


oblong in cross section, and acts as a slide valve. In action and assuming the valves 4 and 19 and piston 26 are in the positions shown in Fig. 1, the steam is admitted into the valve casing 1, and passes down the passage 5 through branch 6, opening 7 in the valve casing 1, and opening 22 in the valve 19, to the pipe 23, and so into the steam cylinder 25 on the underside of the piston 26; at the same time the exhaust is open on the other side of the piston 26, the exhaust steam passing through the pipe 24 and openings 21 and 9, around the portion 14 of the valve 4, and away by the exhaust outlet 3; but so soon as the piston 26 has reached practically the end of its stroke the valve 4 has been moved a half turn, and the branch 8 will come opposite the opening 9 and the opening 7 will be closed, when the steam will pass through the openings 9, 21, and pipe 24 to the top of the piston and act upon same, the openings 7, 22, and pipe 23 being open to the exhaust. Thus the engine will be running in the well-known manner. Now to obtain a reversal of the engine, valve 19 is moved for the opening 27 to correspond with the opening 9 and pipe 23, and the opening 28 to correspond to the opening 7 and tube 24, so that the steam intended for the underside of the piston will be transferred by the passages in the valve 19 to the top of the piston, and *vice versa*, the action otherwise being the same, but, of course, with a reverse movement of the valve 4. (*Sealed.*)

4190/15. Royles, Limited, J. J. Royle and G. E. Royle, Manchester. Steam-Traps. (5 *Figs.*) March 17, 1915.—This invention relates to fluid-operated and thermostatically controlled valve mechanism of the type in which the main valve is governed by the pressure of the fluid to be controlled, acting upon a piston or diaphragm connected to the valve, the pressure being automatically controlled by a thermostatic appliance. The thermostatic appliance, according to the present invention, comprises a capsule enclosing an expansible gas or liquid and operating through a corrugated tube and spindle, which is arranged so as to be affected by the temperature of the liquid or fluid requiring to be controlled. *a* is the main valve casing and *b* the main valve. Connected to the valve is the piston *c* designed to slide within the cylindrical extension *a*1 of the valve casing. The valve casing *a* is joined to the casing *f* of the thermostat. Centrally arranged within the casing *f* is a thermostat capsule, consisting, for example (see Fig. 2), of the cylinder *h*,

Fig.1.



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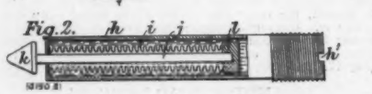


closed at both ends, a corrugated tube *i* and a spindle *j*, this latter passing centrally through the tube *i* and at one end extending loosely through the end of the cylinder *h*, where it is provided with a valve cone *k*. At its other end the spindle is secured to a small block *l*, to which and the end of the cylinder *h* are respectively connected the ends of the corrugated tube *i*. The cylinder *h* is completely filled with an expansible gas or liquid, such as ether, mercury, or glycerine. With the thermostat thus produced and arranged, it will be seen that any increase of heat will cause the gas or liquid in the cylinder *h* to expand, and, by acting upon the end of a block *l*, compress the corrugated tube endwise, and, through the spindle *j*, move the valve cone *k* further away from the cylinder end. Contrariwise, with any subsequent decrease of heat, the gas or liquid will contract and allow the corrugated tube *i*, under its own elasticity, to elongate, and through the spindle, draw the valve cone *k* nearer to the cylinder end. This action of the expansive gas or liquid is used to operate the valve cone *k* for the purpose of covering and uncovering a vent f^5. (*Sealed.*)

100,338. G. and J. Weir, Limited, and C. R. Lang, Glasgow. Steam Turbines. (4 *Figs.*) March 23, 1916.—The object of the invention is to enable the guide-vane-supporting member to be connected to, and supported from, the front of the turbine casing in such a manner with respect to the attachment of the nozzle box and nozzles that the box and nozzles can be removed without interfering with the guide segment. *a* is a turbine casing, *b* the nozzle box, *c* the nozzle member in which are formed the nozzles *n*; *d*, *d* the guide vanes, *e* the guide segment. *h*, *h*, are studs which secure the nozzle box and the nozzle member to the casing, the nozzle

Fig.1.

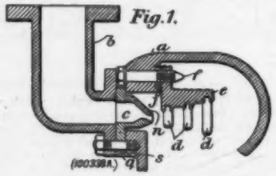
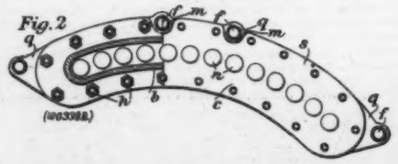


Fig.2

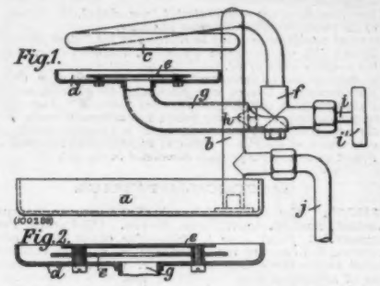


box and nozzle member being formed with flanges *r* and *s* respectively to receive these studs, and the casing being formed with a facing *g* to receive the flange *s*. *f* are bolts or threaded pins which secure the guide segment to the facing *q*, the flange *s* being cut away, as illustrated, to provide room for the nuts or heads of these bolts or pins. *j* are washers employed for convenience of manufacture for the purpose of adjusting the position of the guide segment in an axial direction. In the construction illustrated, the pins *y*, *y* are threaded and screwed into tapped holes in the guide segment, and U-shaped slits or recesses *m* are formed in the nozzle member to provide room for the heads of the bolts *f*, *f*. (*Sealed.*)

MISCELLANEOUS.

100,288. The Lune Valley Engineering Company, Limited, and J. G. A. Kitchen, Lancaster. Bunsen Oil Burner. (3 *Figs.*) January 10, 1916.—A vaporising Bunsen oil burner, according to this invention, has an igniting tray with a vertical closed tube rising therefrom into which oil is forced under pressure, a vaporising coil communicating with the tube and with a nozzle secured to a mixing chamber suspended above the igniting tray and lying alongside of the closed tube, and a burner tray with dispersing diaphragms fed with heated vaporised oil and air from the mixing chamber. The tray *a*, in which spirit is burned to first ignite the burner, has secured thereto a vertical closed tube *b*. To the upper end of the tube *b* is connected one end of a coil of tubing *c*, coiled above the burner tray *d* and a disperser diaphragm *e*, the tubing *c* rising as it passes around the burner tray and then being diverted

Fig.1.



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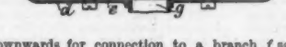


downwards for connection to a branch *f* secured to the open mouth of a mixing chamber *g*. The branch *f* is provided with a nozzle *h*, governed by means of an ordinary needle valve. The mixing chamber is suspended above the ignition tray and is disposed alongside of the tube *b*. It carries the burner tray *d*, opening out and discharging beneath the disperser diaphragm as indicated in section in Fig. 1. The fuel under pressure is fed to the tube *b* by the pipe *j*, and is vaporised in the coil *c* by the flame of the burner and mixed with air in the mixing chamber *g* for consumption at the burner. (*Sealed.*)

100,340. W. J. Mellersh-Jackson, London. (*The Sperry Gyroscope Company, New York, U.S.A.*). **Course-Determining Devices for Aircraft.** (3 *Figs.*) April 24, 1915.—This invention relates to course-determining and correcting devices for aircraft, the chief object being to devise an instrument whereby the aviator may not only detect the side drift of the aircraft and thereby determine the true direction in which he is heading, but also an instrument whereby he may accurately determine the actual direction in which he must point the machine in order to fly upon a predetermined course. According to the invention, the course-determining and correcting device comprises essentially a compass having an adjustable lubber's line adapted to be controlled by the movement of an object-sighting or focussing device utilised for determining drift, whereby the line may be placed in the direction of the true line of flight of the craft. The compass is so adjusted by connection with speed and drift-determining means that the pilot will steer a course duly corrected for the effect of drift without himself having to make any calculation or further adjustment, the compass thus automatically indicating the true direction in which the pilot must head the aircraft in order to keep upon the desired course. An object-sighting or focussing device of any suitable nature may be employed, such as an ordinary telescope or a device which produces a real image upon a screen after the manner of a camera obscura. This device, which is capable of being turned about a vertical axis, may be mounted in any suitable position upon the machine, and a pointer 1 may be secured to it so as to be readable upon a scale 2 on the base 3, whereby the angle through which it is turned may be indicated

Fig.1.

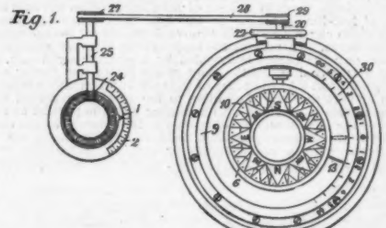


Fig.2.

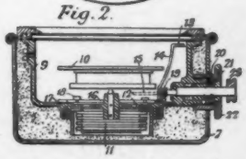
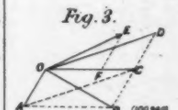


Fig.3.



to the observer. Means are provided within the sighting tube or in conjunction with the screen to indicate to the observer the angle at which the aeroplane is moving with respect to the position of the pointer 1. This means may consist of cross-hairs at least one of which extends normally in the direction of the fore-and-aft line of the aeroplane. The observer then, on looking through the sighting device or at the screen, may readily ascertain whether or not the machine is drifting sidewise by the stream-lines of the objects on the earth passing across the field of vision, and he may readily ascertain the true direction of flight by turning the hairs so that they lie exactly parallel to these stream-lines. The scale 2 will then show the angle of side drift of the aircraft. The compass 6 is operatively connected with the drift machine, and comprises the casing 9 and compass rose or needle 10. Adjustably mounted within the casing is a lubber's line pointer or index 13, which normally is in line with the fore-and-aft or lubber's line of the aircraft, so that the aviator may determine the direction in which the aircraft is heading. The lubber's line index 13 is shown as a pointer 14 extending up from a rotatably-mounted gear sector 15. Rotation is imparted to the sector by means of a pinion 19 on the end of a shaft 20, which extends without the casing and is driven from the drift machine. In addition to the shiftable lubber's line index 13 the compass may be provided with a fixed lubber's scale 30, which will not only serve to show at all times the actual direction in which the aircraft is pointed when read in connection with the compass rose, but will also show the angle through which the shiftable lubber's index has been moved away from its normal position. (*Sealed.*)